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8860A

Digital Multimeter

Operator Manual

FLUKE®

8860A
Digital Multimeter

Operator Manual

FLUKE®

P/N 541268
April 1980

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*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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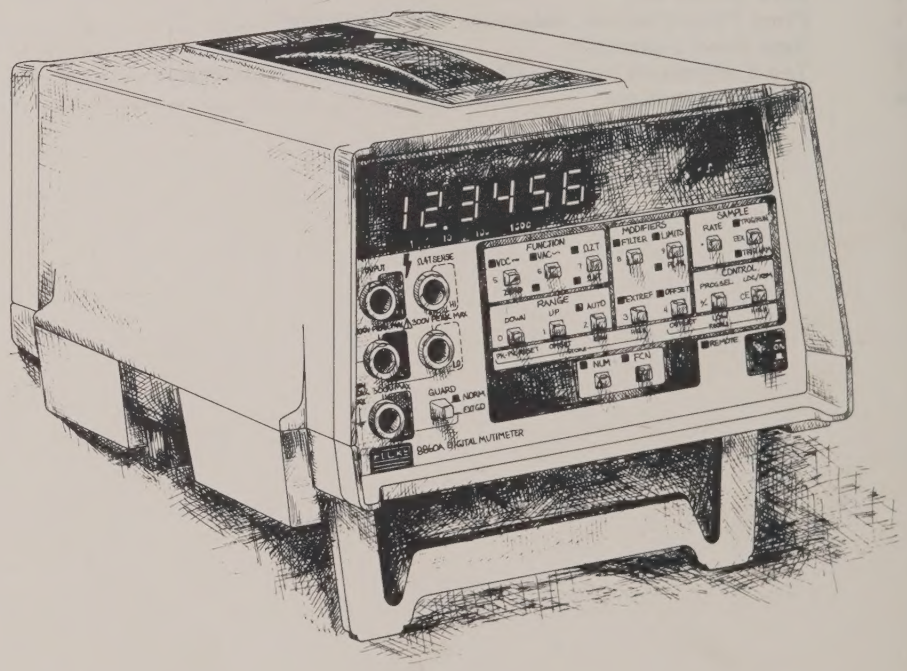


8860A Digital Multimeter

Section 1
Introduction and Specifications

1-1. THE 8860A INSTRUCTION MANUAL SET

1-2. The John Fluke Model 8860A Digital Multimeter is documented by a set of five manuals: Operator, Calibration, Calculating Controller User Handbook, Service, and a Reference Guide. The Operator Manual includes a description of the unit, installation information, operating instructions, and routine operator maintenance. The Calibration Manual is designed for use by the Calibration Technician. It contains specifications, general maintenance information, access procedures, performance tests, and calibration adjustment procedures. The Calculating Controller User Handbook contains the operating instructions for the Calculating Controller Option (-004). The Service Manual contains the theory of operation, troubleshooting information, a list of replaceable parts, and schematics. Condensed operating information for both the 8860A and the Calculating Controller are included in the Reference Guide. The five manuals can be separated for use in different areas or joined together in a single three-ring binder.

1-3. The Operator Manual is divided into the following sections:

1 INTRODUCTION AND SPECIFICATIONS	Introduces the 8860A Instruction Manual Set, describes the 8860A and its features, and lists the instrument specifications.
2 SHIPPING AND SERVICE INFORMATION	Provides unpacking and information. Instructions for contacting your local Fluke Service Center and the John Fluke Mfg. Co., Inc. are also included.
3 INSTALLATION AND MAINTENANCE	Bench-top and rack-panel mounting procedures are followed by an input line voltage verification procedure and operator maintenance procedures.
4 OPERATING INSTRUCTIONS	Includes an illustrated description of the 8860A controls and indicators, detailed operating notes, and operating procedures.
5 OPTION AND ACCESSORY INFORMATION	Provides a description and the specifications for each of the options and accessories available for use with the 8860A. Operating instructions are also provided for the options. Accessory operating information is provided with the individual accessories.

1-4. DESCRIPTION

1-5. The 8860A is a fully-guarded, microprocessor-controlled, 5-1/2 digit, five-function digital multimeter designed for bench-top applications. Its measurement functions include: VDC, true RMS VAC (ac coupled), true RMS VAC (dc coupled), two-terminal ohms, and four-terminal ohms. Each voltage function is provided with five ranges. Six ranges are available for each of the ohms functions. The ranges can be selected automatically (autorange) or manually.

1-6. Several other performance features are provided with the 8860A. They include:

- Total push-button control
- Dual slope a/d conversion
- Push-button zero for V dc and ohms
- Selectable sample rate and resolution (4-1/2 or 5-1/2 digits)
- Selectable internal/external guard connection
- Selectable trigger mode: auto, manual, external
- Three math functions: offset, limits and peak-to-peak.
- Numeric data entry push-buttons for use in loading the constants for the offset, limits, and peak-to-peak functions.
- A 5-1/2 digit measurement display (mantissa) field with sign and floating decimal point.
- A two-digit exponent field with sign for displaying exponents of 10 and high, low, pass (H,L,P) limits information. Exponents are automatically displayed for recalled data.
- Measurement units annunciators that operate in conjunction with the display decimal point to display the selected range.
- Overload protection for all functions and ranges.
- Selectable local/remote operation.

1-7. The 8860A is housed in a plastic Portable Test Instrument (PTI) case. The case includes a retractable carrying handle and a fold-down bail. When extended, the bail provides a convenient tilt for bench-top operation. The PTI design allows the 8860A to be stacked and latched with other instruments in the Fluke PTI product line. Stacking saves bench space and allows the instruments in the stack to be moved as a single unit.

1-8. Operating power for the 8860A is selectable for the following configurations: 100, 120, 220, or 240V ac ±10%; 50 or 60 Hz. The unit is shipped in the configuration specified at the time of purchase. Since the voltages are selectable, they can be reset in the field by a qualified technician. (Instructions for line voltage selection are given in the Calibration manual.)

1-9. Several options and accessories are available for use with the 8860A. The options are listed and briefly defined in Table 1-1. A description of each option and its

specifications and operating instructions are given in Section 5, Option and Accessory Information. (Operation of the Calculating Controller Option (-004) is described in detail in the Calculating Controller Handbook.) Each option is field installable. Option compatibility is defined in Table 1-2.

Table 1-1. 8860A Options

OPTION NO.	DESCRIPTION	FUNCTION
-004	Calculating Controller	Scientific Calculator/Controller
-005	IEEE-488 Interface	IEEE-488 Bus Interface (talker, listener)
-006	Rear Input	Rear input terminals
-007	External Reference	External reference for making ratio measurements

Table 1-2. Option Compatibility

OPTIONS	-004	-005	-006	-007
-004		o		
-005	o			
-006				
-007				
o = Not Compatible				

1-10. Available accessories include panel-mounting kits and a series of probes. Accessory descriptions are included in Section 5 of this manual. Operating instructions are provided with the individual accessories.

1-11. SPECIFICATIONS

1-12. The specifications for the 8860A are given in Table 1-3.

Table 1-3. 8860A Specifications

DC VOLTS

Ranges ..... ±200 mV, 2V, 20V, 200V, 1000V

Ranging ..... Fully automatic or manual

Polarity of Input ..... Automatic polarity selection and display

Resolution (Max.) ..... 0.0005% of full scale (1 uV on 200 mV range) with 5-1/2 digit display.

Accuracy ..... Using front panel zero, ±(% input + no. of digits)

5-1/2 DIGIT DISPLAY*

RANGE	24 HR 23°C ±1°C	90DAY 18°C - 28°C	1 YR 18°C - 28°C	NORMAL MODE REJECTION	
				NO FILTER	FILTER
200 mV	(0.004 + 3)	(0.008 + 3)	(0.01 + 3)	>60 dB 50, 60 Hz	>100 dB 50, 60 Hz
2V-200V	(0.004 + 2)				
1000V					

4-1/2 DIGIT DISPLAY*

RANGE	90DAY 18°C - 28°C	1 YR 18°C - 28°C	NORMAL MODE REJECTION	
			NO FILTER	FILTER
All	(0.01 + 2)	(0.015 + 3)	>60 dB 50, 60 Hz	>100 dB 50, 60 Hz

*Settling Time: 30 ms to within .01% of input step size, with filter 300 ms.

3-1/2 DIGIT DISPLAY (Available with -004 or -005 options only)

RANGE	1 YR 18°C - 28°C	NORMAL MODE REJECTION	
		NO FILTER	FILTER
All	(0.1 + 1)	None	>40 dB 50, 60 Hz

Settling Time: 5 ms to within .1% of input step size, with filter 250 ms.

Common Mode Rejection

CONDITIONS ..... Line frequency switch properly set.
Line frequency at 50 or 60 Hz ±0.1%.
One kilohm in either lead.

4-1/2 AND 5-1/2 DIGIT RATE
- Normal Guard ..... >130 dB
- External Guard (Driven) ..... >150 dB

3-1/2 DIGIT RATE
- Normal Guard ..... >70 dB
- External Guard (Driven) ..... >90 dB

DC, ALL READING RATES .... >160 dB

Input Resistance
- 200 mV, 2V RANGES ..... >10,000 MΩ
- 20V, 200V, 1000V RANGES .... 10 MΩ

Table 1-3. 8860A Specifications (cont)

Input Bias Current (@ 23°C) ..... ≤100 pA
Zero Stability
(after 1 hour warmup) ..... ±10 uV for 90 days
Maximum Input ..... ±1000V Pk input HI to LO
±500V Pk input LO to Earth
±30V Pk input LO to Guard

AC VOLTS (True RMS, AC only or AC + DC)

Ranges ..... 200 mV, 2V, 20V, 200V, 700V

Ranging ..... Fully automatic or manual

Resolution (Max) ..... 0.0005% F.S. (1 uV on 200 mV range) with 5-1/2 digit display.

Accuracy ..... ±(% INPUT + DIGITS), 0.5% F.S. to F. S. AC only*

FREQUENCY	RANGE(S)	90 DAY 18°C-28°C			1 YR 18°C-28°C		
		% INPUT	DIGITS		% INPUT	DIGITS	
			5-1/2	4-1/2		5-1/2	4-1/2
20 Hz-50 Hz	All	0.25	70	10	0 25	100	13
50 Hz-10 kHz	All	0.15	70	10	0.15	100	13
10 kHz-50 kHz	2V-700V	0.4	150	18	0.4	300	33
	200 mV	0.7	150	18	0 7	300	33
50 kHz-100 kHz	2V-700V				1 0	350	38
	200 mV				2.5	350	38
100 kHz-300 kHz	All				8.0	700	73

*For AC + DC operation, add 0.1% of input +50 digits for 5-1/2 digit resolution.
For AC + DC operation, add 0.1% of input + 5 digits for 4-1/2 digit resolution.

Bandwidth (typical) ..... ≤ 3 dB @ 1 MHz

Crest Factor ..... 3 at full range, increasing down range

Input Impedance ..... 10 MΩ, ≤ 70 pF

Maximum Input ..... 700V rms, 1000V Pk, or 2 x 10^7 volt/Hz, whichever is less.

OHMS (2-terminal or 4-terminal)

Ranges ..... 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ

Ranging ..... Fully Automatic or Manual

Resolution (Max) ..... 0.0005% F.S. (1 mΩ on 200Ω range) with 5-1/2 digit display

Table 1-3. 8860A Specifications (cont)

Accuracy ..... Using front panel zero, ±(% of input + no. of digits)

5-1/2 DIGIT DISPLAY

RANGE	24 HR 23°C ±1°C	90 DAY 18°C - 28°C	1 YR 18°C - 28°C
200	(0.008 + 4)	(0.012 + 4)	(0.015 + 4)
2k-200 kΩ	(0.006 + 2)	(0.01 + 2)	(0.013 + 2)
2M	(0.01 + 3)	(0.014 + 3)	(0.017 + 3)
20M	(0.07 + 3)	(0.09 + 3)	(0.10 + 3)

4-1/2 DIGIT DISPLAY

RANGE	90 DAY 18°C - 28°C	1 YR 18°C - 28°C
200 - 2 MΩ	(0.01 + 2)	(0.02 + 3)
20 MΩ	(0.1 + 2)	(0.14 + 3)

3-1/2 DIGIT DISPLAY

RANGE	1 YR 18°C - 28°C
200Ω - 2 MΩ	(0.1 + 1)
20 MΩ	(0.3 +1)

INPUT CHARACTERISTICS

RANGE	CURRENT THRU RX	OPEN CIRCUIT VOLTAGE
200	1 mA	6.0V MAX
2 kΩ	1 mA	
20 kΩ	100 uA	
200 kΩ	10 uA	
2 MΩ	1 uA	
20 MΩ	.1 uA	

Maximum Input ..... 300V DC or Peak AC

Ohms Settling Times

RANGE	5-1/2 and 4-1/2 DIGIT (TO .01% OF STEP)		3-1/2 DIGIT (TO .1% OF STEP)	
	NO FILTER	FILTER	NO FILTER	FILTER
200 - 20 kΩ	100 ms	<300 ms	<15 ms	<300 ms
200 kΩ		<1.1s		<800 ms
2m		<650 ms	<70 ms*	<500 ms
20m	<1.5s*	<6.8s	<600 ms*	<4.5s

*For these ranges the filter is recommended. This will reduce the effects of noise pick-up common to all high impedance measurements.

Table 1-3. 8860A Specifications (cont)

GENERAL

DISPLAY	RESOLUTION (% FS)	MAX READING/SEC	LINE FREQ. (HZ)	A/D INTEGRATE TIME (MS)
5-1/2	0.0005	2.5	50, 60	100
4-1/2	0.005	15 12	60 50	16-2/3 20
3-1/2*	0.05	30	50, 60	2

*Accessible through IEEE-488 or Calculating Controller options only.

Temperature ..... 0°C to +50°C operating; -40°C to +75°C non-operating.

Temperature Coefficient ..... ±0.1 x applicable accuracy specification per °C

Relative Humidity ..... ≤80% to +35°C; ≤70% to +50°C

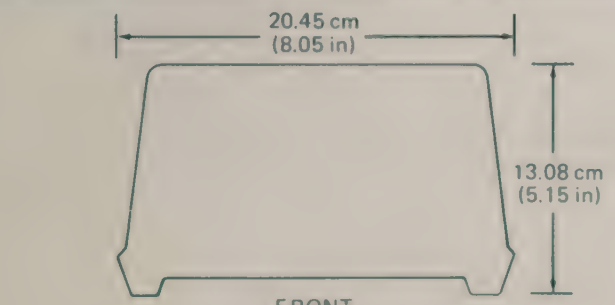
Shock & Vibration ..... MIL-T - 28800B, class 4

Power ..... 100, 120, 220, 240V AC ±10%, 250V AC MAX., 50 Hz or 60 Hz

Size ..... 13.08 cm x 20.45 cm x 32.69 cm (HxWxL) (5.15 in x 8.05 in x 12.85 in) See Figure 1-1.

Weight ..... 3.39 kg (7.48 lbs.)

Protection Class 1 ..... Relates solely to insulating or grounding properties defined in IEC 348



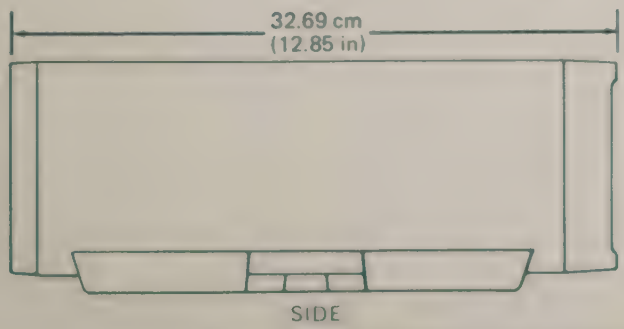


Figure 1-1. Outline Drawing

Section 2
Shipping and Service Information

2-1. INTRODUCTION

2-2. The 8860A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, inspect it throughly for possible shipping damage. Special instructions for inspection and claims are included on the shipping container.

2-3. If reshipment is necessary, use the original container. If the original container is not available, order a new one from John Fluke Mfg. Co., Inc.; P.O. Box 43210; Mountlake Terrace, WA 98043; telephone (206) 774-2211.

2-4. SERVICE INFORMATION

2-5. Each John Fluke Model 8860A Digital Multimeter is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located at the front of this manual.

2-6. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is given in Appendix A. If requested, an estimate will be provided before any work begins on instruments that are beyond the warranty period.

2-7. QUESTIONS/PROBLEMS

2-8. For any additional information, contact your nearest John Fluke Sales Representative (see Appendix A) or the John Fluke Mfg. Co., Inc. at the address or telephone number given above.

Section 3
Installation and Maintenance

3-1. INTRODUCTION

3-2. This section of the manual contains installation and operator maintenance information for the basic 8860A. Review the installation information prior to using the instrument. Have a qualified technician perform any procedures that require internal access to the 8860A. Perform the operator maintenance procedures as required.

3-3. Installation and maintenance procedures that apply to the 8860A Options are included in Section 5 of this manual. The installation of these options must be performed by a qualified technician. However, some routine maintenance procedures, such as battery replacement, can be accomplished by the operator.

3-4. INSTALLATION

3-5. Bench-Top

3-6. The 8860A is designed primarily as a bench-top instrument. It is housed in a Fluke Portable Test Instrument (PTI) case. The case includes: non-marring rubber feet, a fold-down bail for tilting the unit, a retractable carrying handle, and the ability to stack and lock with other PTI instruments.

3-7. The fold-down bail is located on the bottom front of the instrument. To use the bail, pull it away from the bottom of the instrument by its cross-bar, and lock it in the extended position by pressing it up into the case. To retract the bail: pull it out of the locked position, fold it up, and press it into its retracted position latch.

3-8. The stacking feature of the PTI case allows the 8860A to be stacked with, and locked to other Fluke instruments in the PTI product line. Use the following procedure to stack PTI instruments:

1. Locate and pull the black latches on both sides of the unit to their extended position.

2. Place the unit on top of the PTI stack with the front panel toward the front of the stack.

3. When the unit is properly seated, push both latches in. This will lock the unit to the stack.

3-9. Rack-Panel Mounting

3-10. A series of rack-panel-mount kits (accessories) are available for installing the 8860A in a standard 19-inch equipment rack or in a DIN-size panel opening. The available kits are shown in Table 3-1. Typical kit configurations are shown in Figure 3-1. Installation instructions are included with each kit.

Table 3-1. 8860A Panel-Mount Kits

DESCRIPTION	MODEL NUMBER
Rack Mount, 19-inch, Offset-Right	Y2016
Rack Mount, 19-inch, Side-by-side	Y2017
Panel Mount, DIN-Size	Y2021

3-11. Input Line Voltage

3-12. The 8860A is internally configured to operate from a 100, 120, 220, or 240V ac ±10% (250V ac maximum), 50 or 60 Hz ±0.1% power line. A decal on the rear panel of the instrument specifies the voltage selected prior to shipment. The procedure to select another voltage or frequency is given in the 8860A Calibration Manual. The selection procedure should be performed only by a qualified technician.

3-13. Line voltage is applied to the 8860A by way of a rear-panel, three-prong power connector. Use the three-wire line cord supplied with the unit to make the connection between line power and the 8860A. The offset prong on the line cord should be connected to a high quality earth ground.

3-14. OPERATOR MAINTENANCE

3-15. Operator maintenance for the 8860A is limited to cleaning and fuse replacement. Detailed calibration and service procedures are included in the Calibration and Service Manuals.

3-16. Fuse Replacement

3-17. The fuse is located in the lower-left corner of the rear panel. When fuse replacement is necessary, remove the fuse-cap by turning it 1/8 of a turn counterclockwise with a screwdriver. The fuse will pull out with the fuse-cap. Replace the fuse with one of the proper rating:

For 110 or 120V ac, use 1/4A slo-blo 250V
For 220 or 240V ac, use 1/8A slo-blo 250V

3-18. Cleaning

3-19. Periodically clean the front panel using a soft cloth dampened with a mild solution of detergent and water. Use low pressure air (<20 psi) to clear dust from corners, crevices, and rear-panel connectors.

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning the 8860A. They have adverse effects on plastic materials.

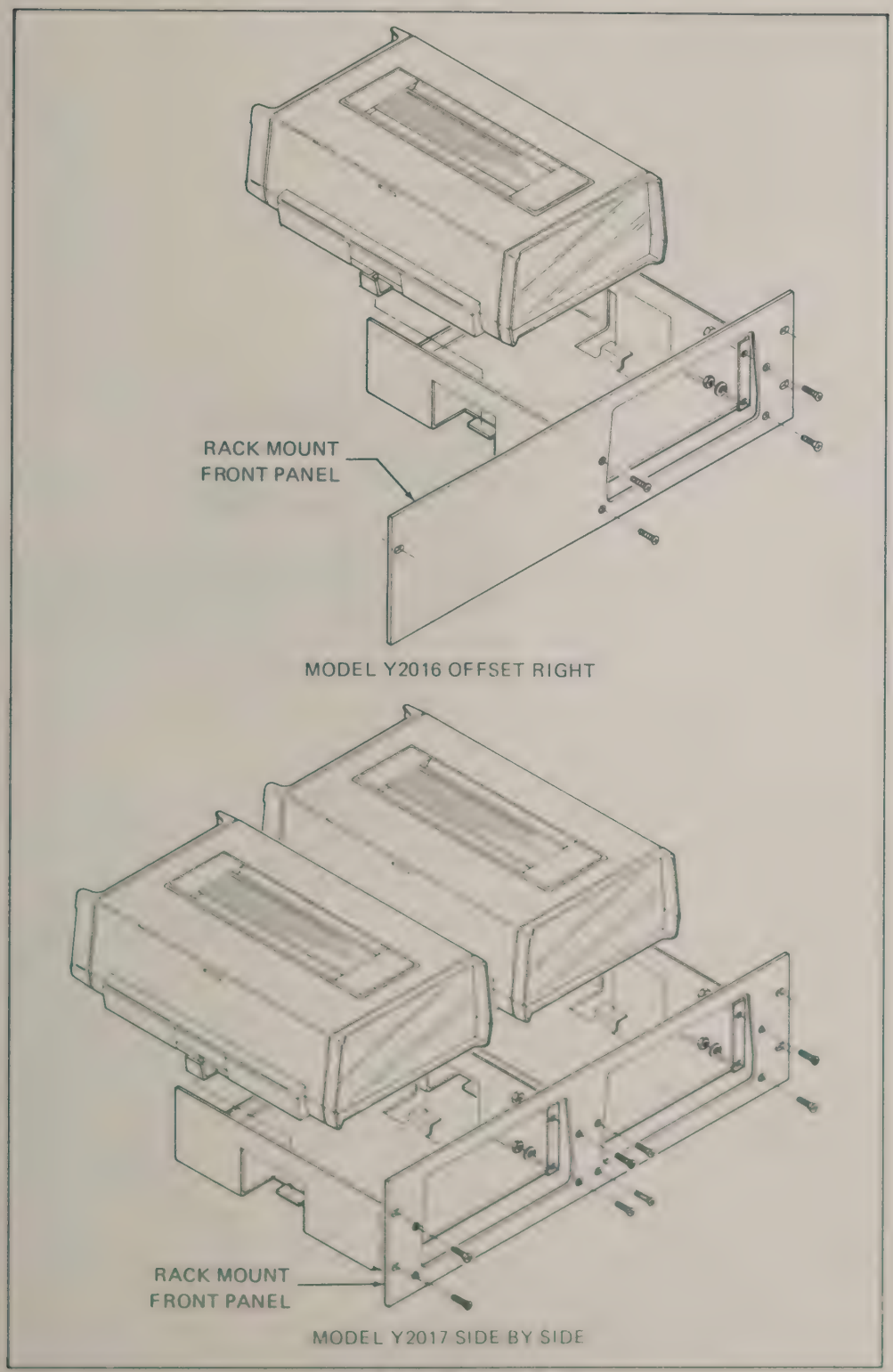


Figure 3-1. Rack Mount Kits

Section 4
Operating Instructions

4-1. INTRODUCTION

4-2. This section of the manual contains the operating instructions for the 8860A. Successful and efficient operation of the 8860A requires an understanding of the unit's features and capabilities. Both are described in detail under Operating Features and Operating Notes. They are followed by operating instructions that assume a knowledge of the instrument's features and capabilities.

4-3. OPERATING FEATURES

4-4. The 8860A front-panel controls, indicators, and connectors are shown in Figure 4-1 and described in Table 4-1. Similarly, the rear-panel features are shown in Figure 4-2 and described in Table 4-2.

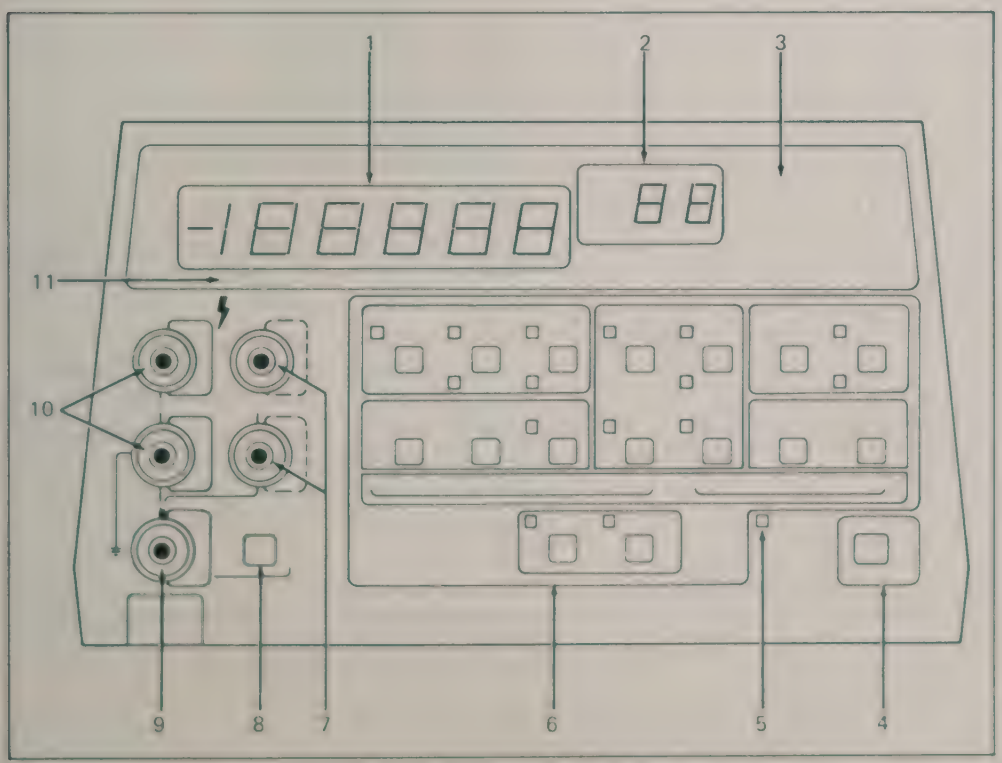


Figure 4-1. Front Panel Controls, Indicators, and Connectors

Table 4-1. Front Panel Controls, Indicators, and Connectors

REF. NO.	NAME	FUNCTION
1	Mantissa Field	The mantissa field is a 5-1/2 digit LED display complete with polarity indicator and a floating decimal point. Measurement data and other operator data is displayed in the mantissa field.
2	Exponent Field	The exponent field is a two digit LED display plus a negative sign. It is used for displaying error codes, limit results (H, L, P), and exponents of 10. Exponents are used for entering, storing, and recalling data. It is not used to display basic measurement data.
3	Annunciators	Measurement units of the selected measurement function are defined by the annunciators. They include: V, mV, Ω, kΩ, and MΩ.
4	POWER Switch	The POWER switch is a push-push switch used to turn the 8860A on and off.
5	REMOTE Indicator	Lights to indicate that the 8860A is in the remote operating mode. When the light is off, the 8860A is in the local mode.
6	Control	All 8860A measurement, control, and data functions are governed by these multi-function push-button switches. The switches are divided into functional groups. They are: Measurement FUNCTIONS Measurement RANGE Measurement MODIFIERS Measurement SAMPLE Local/Remote CONTROL Numeric Data STORE Numeric Data RECALL NUM and FCN (Alternate switch assignment selectors, NUM enables gray assignments, FCN enables rust assignments)
7	Ω4T SENSE Connectors	Two recessed banana connectors (HI and LO). They are used for connecting the sense leads when making four-terminal resistance measurements.
8	GUARD Switch	A push-push switch used to connect the internal guard shield to the GD (guard) connector (EXT GD) or to the LO INPUT connector (NORM). The GD connector is open when the GUARD switch is set to NORM.
9	GD (Guard) Connector	A recessed banana connector for making external guard connections when the GUARD switch is set to EXT GD. The GD connector is open when the GUARD switch is set to NORM.

Table 4-1. Front Panel Controls, Indicators, and Connectors (cont)

REF. NO.	NAME	FUNCTION
10	INPUT Connectors	Two recessed banana connectors (HI and LO). They serve as the input connections for voltage and two-terminal resistance measurements. They operate as the current source output connections when making four-terminal resistance measurements.
11	Range	The range indicators are the decimal points in the mantissa field. The annunciators define the measurement units and the range indicators define the range in terms of the measurement units, e.g., 10 (range indicator), MΩ (measurement units) is the 10 MΩ range).

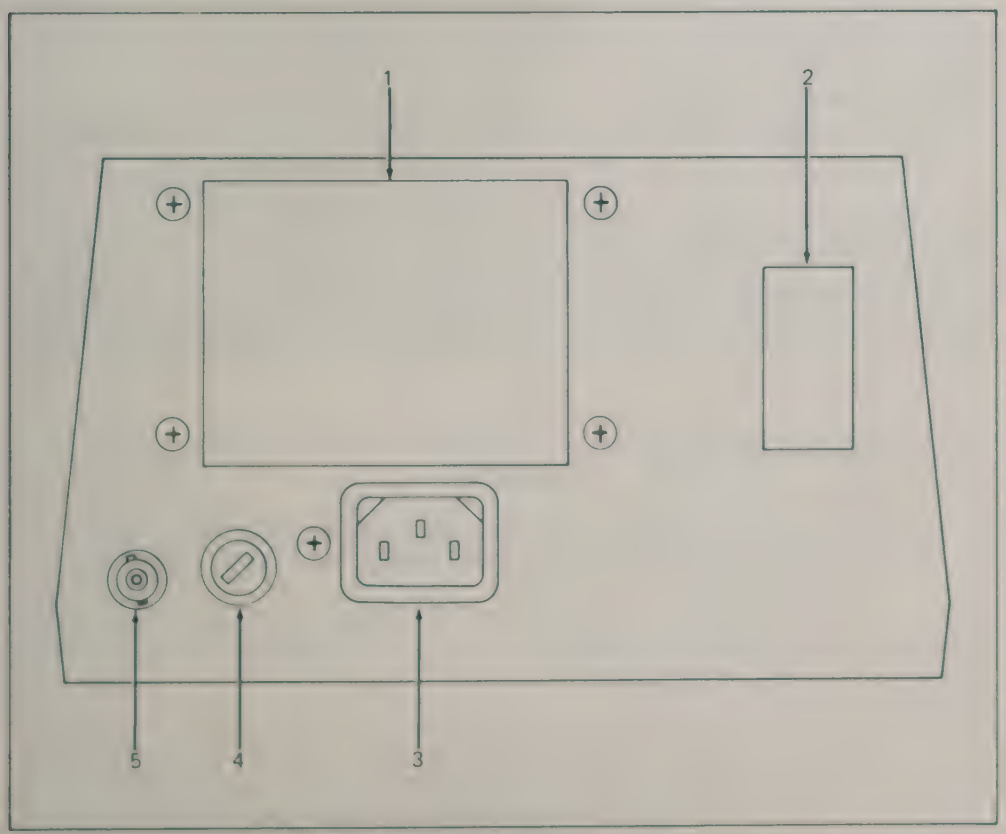


Figure 4-2. Rear Panel Connectors

Table 4-2. Rear Panel Connectors

REF.NO.	NAME	FUNCTION
1	I/O Cover	A protective cover that is present when the Calculating Controller Option (-004) or the IEEE-488 Interface Option (-005) is not installed. Connectors are in this location if either of these options is installed in the 8860A.
2	Rear Input Cover	A protective cover that is present when the Rear Input Option (-006) or the DC External Reference Option (-007) is not installed. Connectors are in this location if either option is installed.
3	Input Power Connector	Three-prong power connector for connecting the 8860A, by way of the line cord, to line power.
4	Fuse	Houses the line power fuse.
5	EXT TRIG Connector	Provides BNC connection for an external trigger input.

4-5. OPERATING NOTES

4-6. The following operating notes describe various conditions, capabilities, and procedures that the operator should be aware of before attempting to operate the 8860A.

4-7. Initial Turn-On

4-8. After input line power is connected to the 8860A, as described in Section 3, turn the unit on by pressing the POWER switch to ON. The unit will initialize to the following configurations: VDC, autorange, all MODIFIERS disabled, slow SAMPLE RATE (2-1/2 readings per second, 5-1/2 digit resolution). The display will remain blank until initialization is complete.

4-9. Input Overload Limits

WARNING

TO AVOID SHOCK HAZARD OR EQUIPMENT DAMAGE, DO NOT APPLY INPUT POTENTIALS THAT EXCEED THE INPUT OVERLOAD LIMITS.

4-10. All 8860A measurement functions are input overload protected. The overload limits are given in Table 4-3. Exceeding these limits may damage the instrument and or pose a shock hazard to the operator.

4-11. Measurement Connections

4-12. There are five test-lead connectors on the 8860A front panel. They are divided into three groups: INPUT HI and LO, SENSE HI and LO, and GD (guard). The following paragraphs discuss test lead connection and the proper use of each of the three connector groups.

Table 4-3. Input Overload Limit

TERMINALS	FUNCTIONS	MAXIMUM INPUT
Input	VDC ⎓ VAC ∿ VAC ⎓∿	HI to LO 1000V peak LO to GD, 30V LO to earth ground, 500V peak
	Ω2T Ω4T	HI to LO 300V dc or peak ac
Sense	Ω4T	HI to LO, 300V peak
EXT TRIG	ALL	5V peak

4-13. INPUT HI AND LO

4-14. Connect the test leads to the INPUT HI and LO connectors for all voltage and two-terminal resistance measurements. The test leads are interchangeable for two-terminal resistance measurements unless a semiconductor device is being measured. In this event, the HI connector lead is positive with respect to the LO connector lead. Test currents and open circuit voltage for all resistance ranges are listed in Table 4-4.

4-15. When making voltage measurements, connect the LO connector lead probe to circuit common or the lowest of the two potentials with respect to earth ground. This establishes the reference level for the measurment and ensures a proper polarity indication for dc measurements. It also minimizes the possibility of exceeding the 500V peak limit between LO INPUT connector and earth ground. Connect the HI connector lead to the highest of the two terminals with respect to earth ground.

4-16. SENSE HI AND LO

4-17. The Ω4T SENSE connectors provide for the connection of sense leads when making four-terminal measurements. They are used in conjunction with the INPUT connectors. A constant test current is supplied to the test resistor through the INPUT connector test leads. The sense test leads are connected across the resistor as voltage sensors. As a result, errors caused by the voltage drop across the INPUT connector test leads are eliminated from the measurement.

Table 4-4. Ω2T and Ω4T Test Current and Open Circuit Voltage

RANGE	TEST CURRENT	OPEN CIRCUIT VOLTAGE
100Ω	1 mA	< 6V dc on all ranges
1 kΩ	1 mA	
10 kΩ	100 uA	
100 kΩ	10 uA	
1 MΩ	1 uA	
10 MΩ	100 nA	

4-18. Proper use of the SENSE HI and LO connector is shown in Figure 4-3. Notice that the HI and LO test leads for both the INPUT and SENSE connectors are paired at

the test resistor, i.e., INPUT HI and SENSE HI are connected together, as are INPUT LO and SENSE LO. The test current and the open circuit voltages for four-terminal measurement are the same as those listed in Table 4-4.

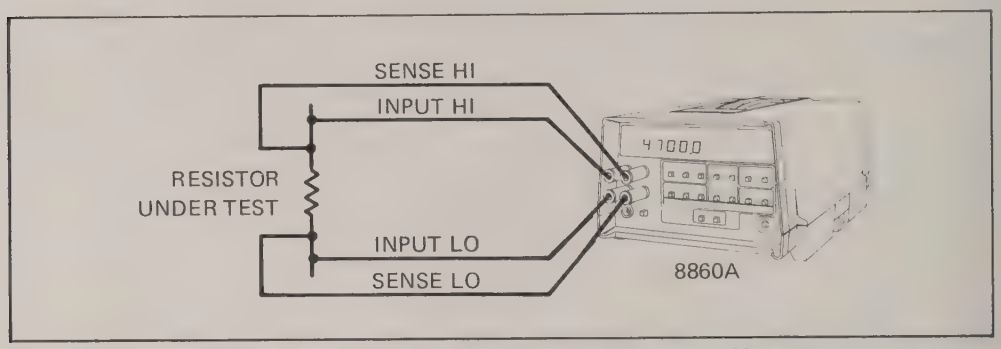


Figure 4-3. Test Connections for Four-Terminal Resistance Measurements

4-19. GD (GUARD)

4-20. The GD connector operates in conjunction with the GUARD switch to eliminate measurement errors associated with common mode voltages which are encountered when making floating measurements. Figure 4-4 shows some typical measurement connections using the guard. If external guarding is not required for a measurement, set the GUARD switch to the NORMAL position.

4-21. The GUARD switch is a two-position, mechanical latching switch. When the switch is set to the out position (NORMAL), it connects the internal guard shield to the LO INPUT connector and disconnects the front-panel GD connector from the internal guard shield. When the Guard switch is set to the in position (EXT GD), it disconnects the internal guard shield from the LO INPUT connector and connects the front-panel GD connector to the internal guard shield.

4-22. Display Indications

4-23. The display, as shown in Figure 4-1, consists of a 5-1/2 digit mantissa field, a two digit exponent field, range indicators, and function annunciators. A given display reading uses a combination of these indicators to communicate with the user. Display information is presented in one of the following forms: measurement data; overrange overvoltage indications; high, low, pass indications; numeric input data and error codes.

4-24. MEASUREMENT DATA

4-25. Basic measuremnt data is displayed in the mantissa field as a 4-1/2 or 5-1/2 (selectable) digit reading with a floating decimal point and function annunciator. Range information is provided by the decimal point and a function annunciator. The exponents are not used in displaying measurement data.

4-26. OVERRANGE AND OVERVOLTAGE

4-27. An overrange display indicates a reading above the limit or capability of the present range. It appears as a 1 in the most significant digit of the mantissa field (with polarity for VDC), and the decimal point indicates the range. The rest of the display is blank. Removing the input condition or changing to an acceptable range clears the indication.

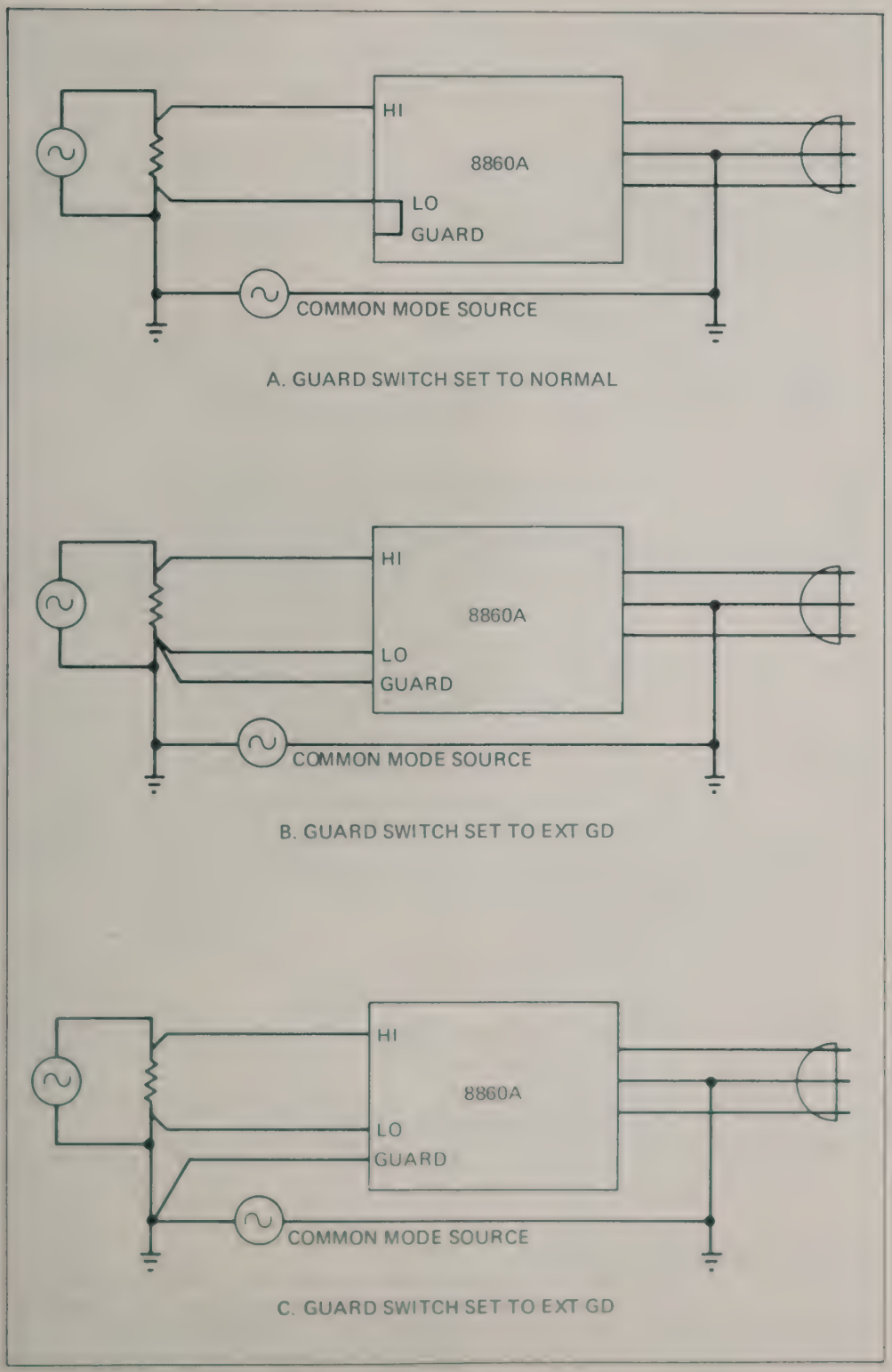


Figure 4-4. Guard Connections

4-28. An overvoltage display indicates that the input voltage level exceeds the maximum input specified for the instrument (1000V dc or 700V rms ac). It only occurs on the 1000V range. The display will indicate the measured value, but will flash to indicate the overvoltage condition and the potential for instrument damage.

4-29. HIGH-PASS-LOW

4-30. Part of the display for limits and pk-pk measurements is a single H, P, or L (high, pass, or low) character in the exponent field. This character is the result of a comparison and complements the measurement data. Refer to the limits and pk-pk functions described later in this section.

4-31. NUMERIC INPUT DATA

4-32. Numeric data can be entered manually from the front panel of the 8860A. The data is displayed as it is entered. It appears as a left justified, dimensionless number with a decimal point. Exponents may be used with numeric input data. The exponent field includes polarity and a two digit exponent of 10.

4-33. ERROR CODES

4-34. The 8860A has built-in diagnostic software for analysing operation of the front-panel controls. An error code is displayed when an improper operation is detected. The code is displayed as Err in the mantissa field and a two digit number in the exponent field. Table 4-5 lists and defines the 8860A error codes. Errors that are not caused by hardware failures are automatically cancelled when the next reading is taken or another function is selected.

Table 4-5. 8860A Error Codes

ERROR CODE	DEFINITIONS
10	External reference not present. Connect reference or cancel selection.
11	Input greater than analog zero range (99 uV or 99 mΩ). Verify DMM Calibration.
12	A/D data received is not BCD.
13	Exponent magnitude too large.
14	Guard Crossing data error. Cannot start receiver.
15	Guard Crossing data error. Bit error in receiver.
16	Guard Crossing data error. Cannot start transmitter.
17	Guard Crossing data error. Bit error in transmitter.
18	Offset result cannot be displayed. Overrange indication has priority over display of this error code. Reduce offset or input.

4-35. Front-Panel Push Buttons

4-36. All push-button switches on the 8860A front panel; except NUM, FCN, GUARD, and POWER; have multifunction assignments. Their primary assignments are labeled in black above each switch. Alternate assignments are labeled in gray and rust, beside and below each switch. The alternate functions are enabled by pressing either the NUM or the FCN switch. The NUM switch enables the gray functions next to the

switches. The NUM light is lit while the gray functions are enabled. Pressing NUM again turns off the NUM light and returns the push-button switches to their primary (black) assignments. The FCN switch is used in the same manner as the NUM switch. Pressing FCN enables the rust switch assignments.

4-37. The black and rust assignments are used for DMM control and storage functions. The gray assignments are the equivalent of a numeric keyboard; they are used to manually enter numeric data. Numeric entries are used in conjunction with, and as supplements to the control and storage functions. Each of the front-panel switch assignments and the proper use of each switch is described in the following paragraphs. The descriptions are keyed to the switch grouping as outlined on the front panel.

NOTE

The function and operation of the POWER and GUARD switches are described earlier in this section under Initial Turn-On and Measurement Connections.

4-38. FUNCTION

4-39. The FUNCTION switches provide for the selection of the measurement function. They are electronically interlocked so that only one function can be selected at any given time. Available functions include: VDC, VAC ∿ , VAC ⎓∿ , Ω2T, Ω4T. Pressing any one of the FUNCTION switches will enable that function and disable the previous function. Remember, the alternate rust assignments require the use of the FCN switch. Proper selection is verified by a light next to the switch assignments. (The ZERO function is a momemtary control and does not require a light).

4-40. Each of the FUNCTION switches, their operation, and their interaction with switch groups is described in the following list:

☐ VDC ⎓

☐

The VDC ⎓ function is used for making dc voltage measurments. It can be used in conjunction with the FILTER MODIFIER and the ZERO FUNCTION switches. Noise rejection is improved when the filter is enabled. Unwanted voltage offsets can be eliminated from a measurment by enabling the ZERO function. The proper use of the zero feature is described later in this list.

☐ VAC ∿

☐

⎓∿

The VAC ∿ function is used for making ac coupled, true rms ac voltage measurements. The FILTER and the ZERO switches have no affect when the VAC ∿ function is enabled.

The VAC ⎓∿ function is used for making dc coupled, true rms ac voltage measurements; the dc component is included in the measurement result. The FILTER and the ZERO switches have no affect when the VAC function is enabled.

☐ Ω2T

☐

The Ω2T function is used for making two-terminal resistance measurements. The measured resistance is sensed at the INPUT connectors. As a result, lead resistance is included in the measurement. Short the test leads and enable the ZERO function to eliminate unwanted lead resistance from the measurement. The zero for VDC and Ω2T are separate and independent operations. Enable the FILTER to improve noise rejection.

Ω4T

The Ω4T function is used for making four-terminal resistance measurements. The measured resistance is sensed at the test resistor. As a result, lead resistance is eliminated from the measurement. Proper connections for four-terminal resistance measurements are described earlier in this section under Input Connections. The ZERO and FILTER are functional if required.

ZERO

The ZERO function is used for making zero offset corrections when using the VDC, Ω2T, or Ω4T measurement functions. Separate and independent corrections are stored for VDC and ohms. To correctly zero a function, short the test leads and enable the ZERO function. Zero corrections are limited to the range of ±99 uV or 99 mΩ. An Err 11 is displayed if the correction value is not within the usable range.

4-41. RANGE

4-42. Measurement ranges for the enabled measurement function are selected using the RANGE switches. These include: AUTO (autorange), UP, and DOWN. Autoranging is enabled or disabled each time the AUTO switch is pressed (toggle operation). The operation and interaction of the switches is described in the following list:

AUTO

Autorange is enabled when the AUTO light is on. When the light is off, ranges are selected manually using the UP and DOWN switches. When autorange is disabled the present range remains enabled, as indicated by the decimal point in the mantissa field.

Autorange is disabled by pressing the AUTO switch to turn off the AUTO light. It is also disabled when the UP or DOWN switch is pressed, and the indicated range change is possible. If a change is not possible (i.e., the highest, UP, or lowest, DOWN, range is already selected), autorange remains enabled.

UP

The UP switch is used to manually select the ranges above the one indicated by the decimal point in the mantissa field. Each press of the UP switch increments the 8860A to the next higher range. If it is pressed while autorange is enabled, it cancels autorange and selects the next higher range. If a higher range is not available, the command is ignored unless a voltage function is enabled. In this event autorange is cancelled.

DOWN

The DOWN switch is used to select the ranges below the one indicated by the decimal point in the mantissa field. Each press of the DOWN switch decrements the 8860A to the next lower range. If it is pressed while autorange is enabled, it cancels autorange and selects the next lower range. If a lower range is not available, the command is ignored.

4-43. MODIFIERS

4-44. The MODIFIER switches control independent functions that supplement the basic measurement functions. They include: FILTER, LIMITS, PK-PK, EXT REF, and OFFSET. The switches operate in a toggle fashion and are not interactive except for LIMITS and PK-PK. A light next to each switch is lit when the modifier is enabled. The function and operation of each of the MODIFIER switches is given in the following list.

FILTER

The filter, when enabled, provides additional noise rejection for measurements using the VDC, Ω2T, and Ω4T FUNCTIONS. The VAC ∿ and VAC ⎓∿ FUNCTIONS are not affected by the FILTER modifier. When the FILTER light is on the filter is enabled.

EXT REF

The EXT REF modifier is functional only when the External Reference, Option -007, is installed in the 8860A. If the External Reference Option is not installed, an error code (Err 10) is displayed when EXT REF is enabled.

When the External Reference Option is installed and enabled, a voltage applied to the rear panel EXT REF terminals (±1 to 11V dc) is used in place of the internal voltage reference. Measurements are displayed as 10X the ratio of the input voltage (VDC, VAC ∿, or VAC ⩝) to the external reference voltage. Refer to Section 5 of this manual for a description of the External Reference function and details for making resistance ratio measurements.

OFFSET

The offset feature is used to subtract the numeric contents of the Offset Data Register from the present measurement and display the result. An error code, Err 18, is displayed when the computed offset value is beyond range for the selected measurement function.

The offset value subtracted from the display is stored in the Offset Data Register. The stored value can be taken from a displayed reading or keyed in manually from the front panel. Stored data is retained for future use when the offset function is disabled. Instructions for storing and recalling data from the Data Registers are given later in this section under Data Registers and Alternate Switch Assignments.

LIMITS

Pressing the LIMITS switch will enable the limits function and cancel the PK-PK function if enabled. The limits function compares the present measurement to the contents of the High and Low Data Registers and displays an L, P, or H in the exponent field.

H when reading is > high limit
L when reading is < low limit
P when low ≤ reading ≤ high

PK-PK

Enabling the PK-PK function cancels the LIMITS function if enabled. The PK-PK function is used to store the high and low level changes that occur about a reference level. It can be used with all measurment functions.

When a PK-PK measurement is initiated, each new measurement is compared with the values stored in the High/Low Data Registers. If the measurement is higher than the high limit value, the High Data Register is updated to the measurement value, and an H is displayed momentarily in the exponent field. If the measurement is lower than the measurement value, the Low Data Register is updated to the measurement value, and an L is displayed momentarily in the exponent field.

The high and low limit values can be set to specific values prior to starting PK-PK measurements, or they can both be preset to the present measurement value. Instructions for operating the Data Registers are given later in this section.

4-45. SAMPLE

4-46. The SAMPLE switches are used to select the trigger mode and to establish the display resolution. Trigger selections include continuous, manual, and external. Two

switches control the sample mode: TRIG ARM and RATE. The TRIG RUN switch is used primarily as a manual trigger. The function and operation of each of the SAMPLE switches follow:

RATE

The Rate switch selects one of two continuous sample rates. Display resolution and integration period are a function of the selected sample rate. The sample rates (readings per second, rps) resolution (digits), and integration periods (ms) are as follows:

1. 2-1/2 rps, 5-1/2 digits, 100 ms
2. 15 rps (60 Hz), 4-1/2 digits, 16-2/3 ms
   12-1/2 rps (50 Hz), 4-1/2 digits, 20 ms

The selected reading rate (slow or fast) can be determined by observing the TRIG/RUN light while continuous sample is enabled. The light blinks once for each sample.

TRIG ARM

The TRIG ARM switch is used to select the trigger mode (continuous sample or trigger sample). Continuous sample is enabled when the TRIG ARM light is off. When the TRIG ARM light is on, continuous sample is disabled. However, the selected resolution and integration period are not altered. A sample is initiated by pressing the TRIG/RUN switch or by using an external trigger at the rear-panel EXT TRIG connector. The TRIG/RUN light blinks to indicate that a sample is being taken.

TRIG/RUN

The TRIG/RUN switch is active when the TRIG ARM light is on. It is used in the local mode to manually initiate a measurement. The TRIG/RUN light blinks to indicate that a measurement is being taken.

In the remote mode, the TRIG/RUN switch is used with the Calculating Controller (Option -004) as a RUN command. It is also used with the IEEE-488 Interface (Option -005). Refer to Section 5 of this manual for information concerning the -004 and -005 Options.

4-47. CONTROL

4-48. The CONTROL switches are used to select the operating mode (local or remote) and remote programs associated with the Calculating Controller (Option -004). They include: LOC/REM and PROG SEL. They are active only when either the Calculating Controller (-004) or the IEEE-488 Interface (-005) Option is installed. The operation of each is described in the following list:

LOC/REM

The LOC/REM switch alternately selects the local and remote operating modes. When remote is enabled, the REMOTE light (to the left of the POWER switch) is on. Local operation is enabled when the light is off.

PROG SEL

The PROG SEL switch is only active in the local mode. When it is pressed (in local), measurement samples are stopped and a P is displayed in the mantissa field. The P is a prompt to enter a program label (0 - 9) for selecting a remote Calculating Controller program.

4-49. DATA REGISTERS (OFFSET - HIGH - LOW)

4-50. The Data Registers are used in conjunction with the OFFSET, LIMITS, and PK-PK MODIFIERS. They are controlled by the STORE and RECALL switch groups. The STORE switches are used to enter numeric display values into the registers. The values

can be taken from a measurement reading or from manually entered data using the front-panel numeric switches (i.e., the gray switch assignments associated with the NUM switch). The RECALL switches are used to display the values present in the registers.

4-51. When the 8860A is initially turned on, the Data Registers are reset to zero. To verify the contents of each of the registers, press the FCN switch followed by one of the RECALL switches. The contents of the recalled register is displayed as long as the RECALL switch is held in. The display returns to the measurement function within a few seconds after the switch is released.

4-52. Values are stored in the Data Registers as dimensionless numbers expressed as exponents of 10. However, when the number is selected for storage it does not have to be expressed as a exponent of 10. Thus, measurement values can be stored directly from the display or they can be manually entered. The exponent of 10 conversion is accomplished by the 8860A.

4-53. The range of values that can be stored in the Data Register is ±1.99999 ±99. If the maximum value is exceeded, an error code, Err 13, is displayed. A summary of the Data Register operations follows:

STORE Use these switch sequences to store presently displayed numeric values (including exponents if any) in the addressed Data Register:

FCN STORE OFFSET
FCN STORE HIGH
FCN STORE LOW

Use this switch sequence to store presently displayed numeric values (including exponents if any) in both the High and Low Data Registers.

FCN STORE PK-PK

RECALL Use these switch sequences to recall stored numeric values to the display. The recalled value is displayed while the RECALL switch is held in. The value is removed from the display a few seconds after the switch is released.

FCN RECALL OFFSET
FCN RECALL HIGH
FCN RECALL LOW

4-54. ALTERNATE SWITCH ASSIGNMENTS (SHIFT)

4-55. The FCN and NUM switches are toggle action switches, push to enable, push to clear. They are used to enable or clear the alternate rust and gray switch assignments. The FCN switch controls the rust assignments, and the NUM switch controls the gray assignments. Selecting either assignment will cancel the other. A light next to each switch (FCN or NUM) is turned on to indicate the enabled assignmetns. When both lights are turned off, the primary (black) switch assignments are enabled. The operation of both the rust and gray switch assignments is described in the following list:

☐ FCN

Press the FCN switch to turn on the FCN light and enable the rust switch assignments. Continuous sampling is stopped and the NUM (gray) switch assignments are cleared if active. Perform the desired rust function by pressing the appropriate switch. After the function is executed, the FCN light is turned off, clearing the rust assignments.

□ NUM

Press the FCN switch to turn on the NUM light and enable the gray switch assignments. Continuous sampling is stopped and the FCN switch asssignments are cleared if active. Perform the desired numeric entry using the switches as a numeric keyboard. Enter digits, decimal point, and change sign (+/-) before keying in the two-digit exponent (EEX) and its sign. Use the clear entry (CE) switch to cancel an entry. The following guidelines apply to the entry of numeric data:

1. Numbers that have a floating decimal point and are within the range of ±1.99999 ±99 may be entered in the mantissa field. The decimal point is ignored after its first use, and numeric entries are ignored after the field is filled.

2. The change sign (+/-) is active in the mantissa field until EEX is pressed. It is then active in the exponent field.

3. Exponents enter the field on the right and shift to the left.

4. The normal exit sequence from a numeric entry is to store the value in one of the Data Registers (PK-PK Reset, Offset, High, or Low). Each store sequence is as follows:

FCN STORE PK-PK RESET
FCN STORE OFFSET
FCN STORE LOW
FCN STORE HIGH

4-56. OPERATION

4-57. With reference to the previous paragraphs, use the following procedures to make voltage and resistance measurements.

4-58. Turn-On Procedures

4-59. Use the following procedure to turn on the 8860A.

1. Verify the line power requirements shown on the rear of the 8860A, and connect the unit to an appropriate power line. Use the line cord supplied with the unit.

2. Set the POWER switch to ON. The display remains blank until the unit is initialized. Initial front panel conditions are: VDC, autorange, 5-1/2 digit display.

4-60. Making Measurements

4-61. The same basic procedure is used for making all measurements. The only exception is the use of the ZERO and FILTER switches. They are only functional when making VDC or resistance measurements. Proceed as follows:

1. Select the desired FUNCTION.

2. Select the desired RANGE.

3. Connect the appropriate test leads, and ZERO the display if the VDC, Ω2T, or Ω4T FUNCTION is selected.

4. Select the desired MODIFIERS.

5. Select the desired SAMPLE conditions.

6. Connect the test leads to the test circuit and, if continuous sample is not enabled, trigger a sample. The measurement will appear on the display.

7. STORE and RECALL data as required to satisfy the enabled MODIFIERS and the measurement requirements.

Section 5
Option and Accessory Information

OPTION/ MODEL NO.	DESCRIPTION	PAGE
	ACCESSORIES	
Y2016	Offset Rack Mount Kit	500-1
Y2017	Side-by-Side Rack Mount Kit	500-1
Y2021	PTI-to-DIN-Panel Adapter	500-1
Y2023	Accessory Case	500-2
Y7203	2-Foot Ribbon Cable, PTI	500-2
Y7204	5-Foot Ribbon Cable, PTI	500-2
Y8001	IEEE-488 Cable, 1 meter	500-2
Y8002	IEEE-488 Cable, 2 meter	500-2
Y8003	IEEE-488 Cable, 4 meter	500-2
Y8100	DC/AC Current Probe	500-2
Y8134	Test Lead Set	500-4
Y8140	Test Lead Set	500-4
Y8833	Memory Cartridge (for -004 option only)	500-4
80K-40	High Voltage Probe	500-6
80T-150	Temperature Probe	500-7
81RF	High Frequency Probe	500-8
82RF	High Frequency Probe	500-9
80J-10	Current Shunt	500-10
	OPTIONS	
-004	Calculating Controller	004-1
-006	Rear Input	006-1
-007	External Reference	007-1

5-1. INTRODUCTION

5-2. This section of the manual documents the accessories and options available for use with the 8860A. It consists of a table of contents and an introduction followed by a series of subsections. The first subsection provides a description and the specifications for each of the applicable accessories. Subsequent subsections document the available options.

5-3. Unique page and paragraph numbers are used to identify each of the subsections. For example, the 500-x series identifies the accessories, and the 004-x series identifies the subsection for the -004 Option (where x is the sequential page and paragraph number).

Accessories

500-1. INTRODUCTION

500-2. This subsection describes the accessories available for use with the Model 8860A Digital Multimeter. Each accessory is described separately. The description is intended to acquaint the prospective user with the features and capabilities of the accessory. Further information is supplied with the accessory.

500-3. Y2016 OFFSET RACK MOUNT KIT

500-4. The Y2016 Rack Mount Kit is illustrated in Section 3 of this manual. It supports a single D-size PTI instrument, such as the 8860A, in a standard 19-inch equipment rack. The instrument occupies the right half of the mounting panel; the left half of the panel is blank.

500-5. Y2017 SIDE-BY-SIDE RACK MOUNT KIT

500-6. The Y2017 Rack Mount Kit supports two D-size PTI instruments side-by-side in a standard 19-inch equipment rack. The Y2017 is illustrated in Section 3 of this manual.

500-7. Y2021 PTI-TO-DIN PANEL ADAPTER

500-8. The Y2021, shown in Figure 500-1, adapts a single D-size PTI instrument, like the 8860A, to a panel with a DIN-size opening. The supplied front panel dimensions are 14.55 cm x 21.4 cm.

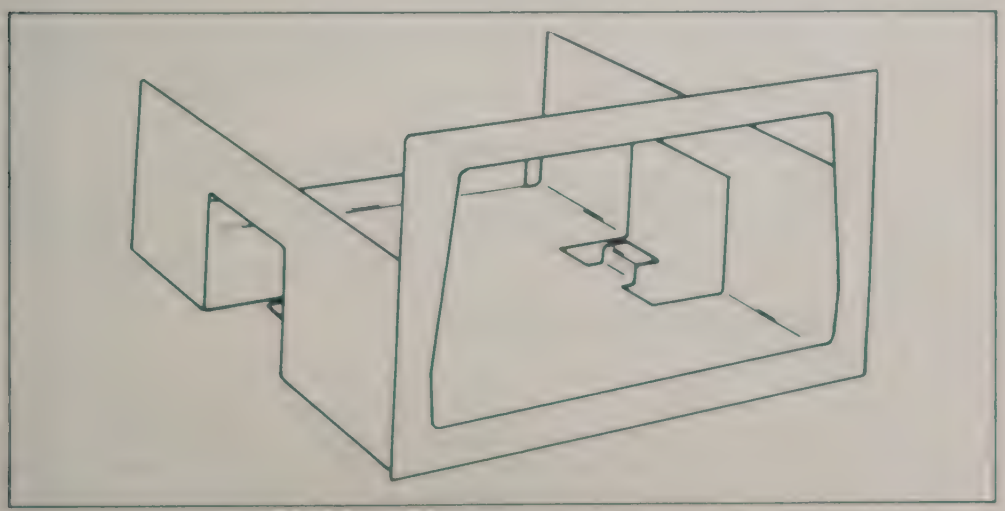


Figure 500-1. PTI-to-DIN Panel Adapter

500-9. Y2023 ACCESSORY CASE

500-10. The Model Y2023A is a PTI-style case. As shown in Figure 500-2, it has a sliding drawer that provides convenient storage for small accessories. It is designed to stack with and latch to the 8860A.

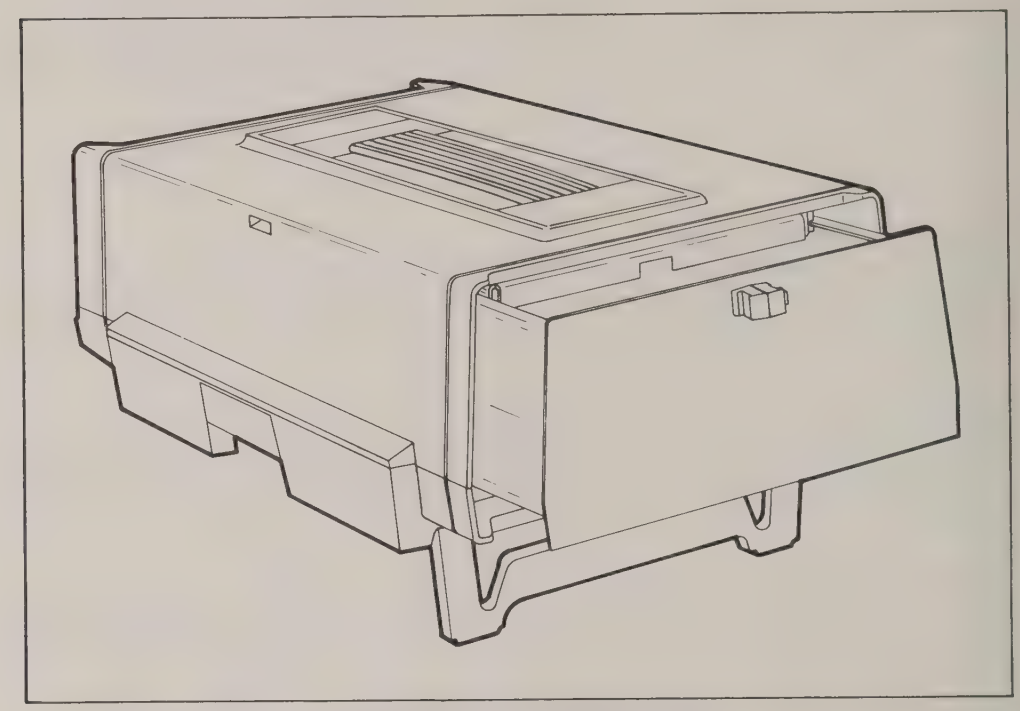


Figure 500-2. Y2023 Accessory case

500-11. Y7203, Y7204, PTI RIBBON CABLE

500-12. Accessory Models Y7203 and 7204 are 36-conductor cables used to connect the Calculating Controller (Option -004) to an external printer. The cables are identical except for length; Y7023 is 2 feet and Y7204 is 5 feet. Amp Champ, 36-pin connectors are provided on both ends of the cable; male on one end, female on the other.

500-13. Y8001, Y8002, Y8003 IEEE-488 CABLES

500-14. IEEE-488 cables are available in three lengths: 1 meter (Y8001), 2 meter (Y8002), and 4 meter (Y8003). See Figure 500-3. These cables attach the 8860A-005 to any other IEEE device. Each cable has double IEEE 24-pin connectors at both ends to enable stacking. Metric-threaded mounting screws are provided with each connector.

500-15. Y8100 DC/AC CURRENT PROBE

500-16. Description

500-17. The Model Y8100, as shown in Figure 500-4, is a battery-powered clamp-on current probe for measuring currents up to 200A dc or ac rms. Two ranges are provides on the probe, 20A and 200A. The probe produces a dc output voltage proportional to the measured current. At full scale the output of the probe is 2V dc. Current carrying conductors up to 1.9 cm (0.75 inches) in diameter can be placed within the probe clamp. Batteries and a 5-foot cable (dual banana plug on both ends) are supplied with the probe.

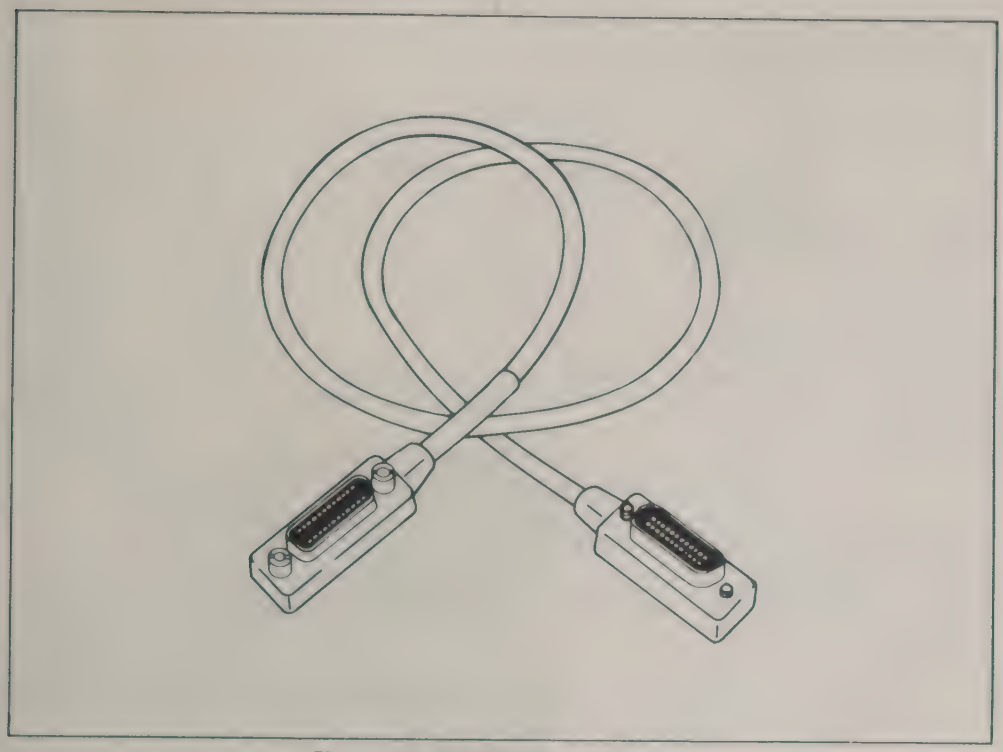


Figure 500-3. IEEE-488 cable

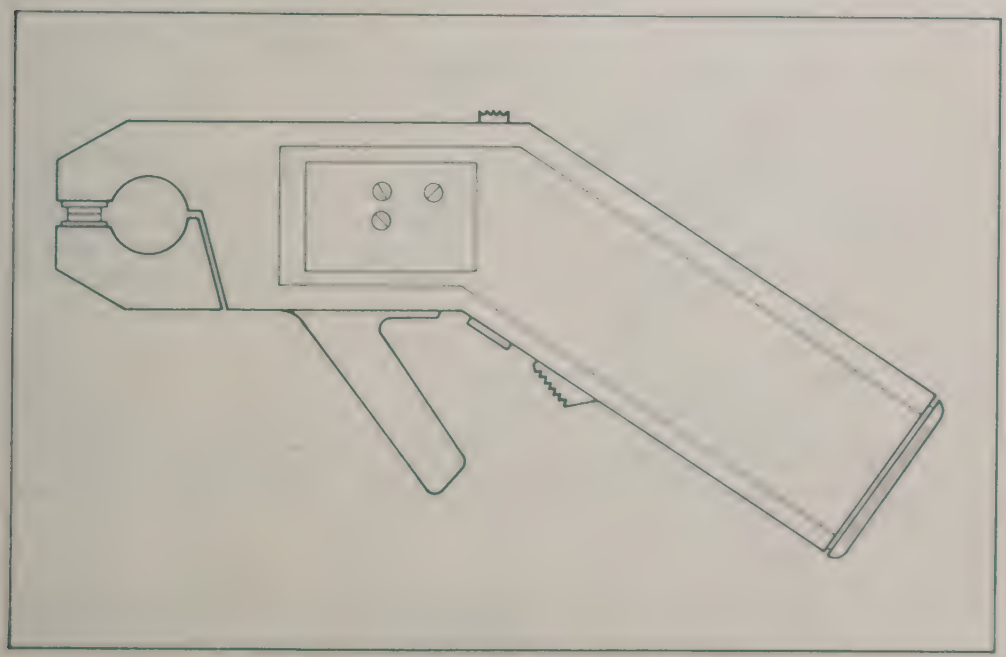


Figure 500-4. Y8100 DC/AC Current Probe

500-18. Specifications

FULL RANGE OUTPUT	2V dc
ACCURACY (Output)	
DC to 200 Hz	±2% of Range
200 Hz to 1 kHz	<100A add ±3% of reading >100A add ±6% of reading
FREQUENCY RESPONSE	dc to 1.0 kHz
RECOMMENDED LOAD	>3 kilohms
TEMPERATURE RANGE	
Operating	+15°C to +35°C
Storage and Operation at Reduced Accuracy	-10°C to +50°C
HEATING LIMITATION	Prolonged operation above 200A ac or 1 kHz can damage the probe
WORKING VOLTAGE RATING	Core to output: 600V dc or 480V ac maximum Output to ground: 42V dc or 30V ac maximum

500-19. Y8134 TEST LEAD SET

500-20. Description

500-21. The Y8134 Test Lead Set is shown in Figure 500-5. It includes a pouch and the following attachments:

1. Two test leads (one red, one black) with shrouded banana connectors at both ends. Rated 10A max, 2000V max.

2. Two test probes (one red, one black). Rated 10A max, 2000V max.

3. Two insulated alligator clips (one red, one black).

4. Two spade lugs.

5. One squeeze hook. Rated 1A max, 1000V max.

500-22. Y8140 TEST LEAD SET

500-23. The Y8140 Test Lead Set consists of one red and one black 60-inch (1.52 meter) test lead, as shown in Figure 500-6. Each lead has a standard banana plug on one end and an extendable tip probe on the other. This flexible metallic tip conductor may be extended up to 2-1/2 inches, and has a clear insulation to within 1/10 of an inch of its tip. Intended primarily for measuring voltages (to 1000V rms), the Y8140 leads may also be used for measuring currents to 2A.

500-24. Y8833 MEMORY CARTRIDGE

500-25. The Y8833 Memory Cartridge is shown in Figure 500-7. It is used with the Calculating Controller (Option -004). It contains the program memory plus the first ten data registers for the Controller. It plugs into the rear of the 8860A-004. Instructions for installing and using the cartridge are given in the Calculating Controller User Handbook. One Y8833 is provided with the -004 option.

500-26. Two watch batteries are used inside the Y8833 to continuously maintain the memory when the cartridge is not powered by the 8860A. Life expectancy for the batteries is at least 1 year. The procedure for replacing the batteries is given in Appendix F of the Calculating Controller User Handbook.

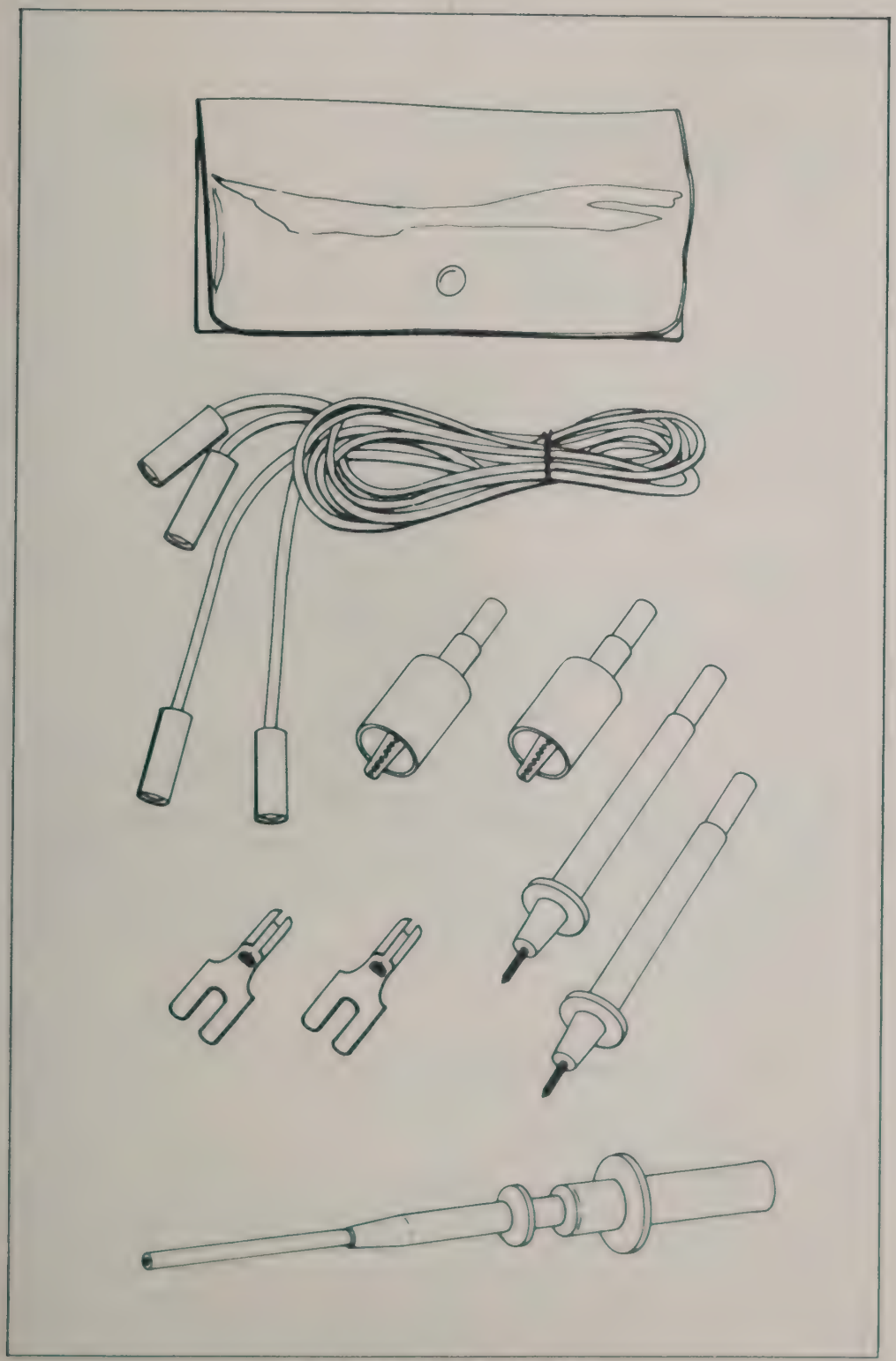


Figure 500-5. Y8134 Test Lead Set

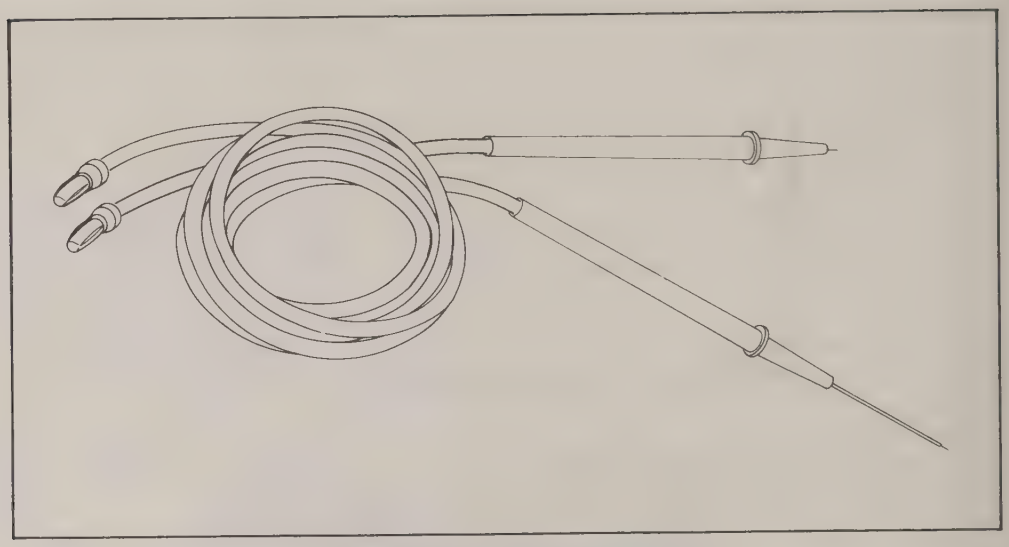


Figure 500-6. Y8140 Test Lead Set

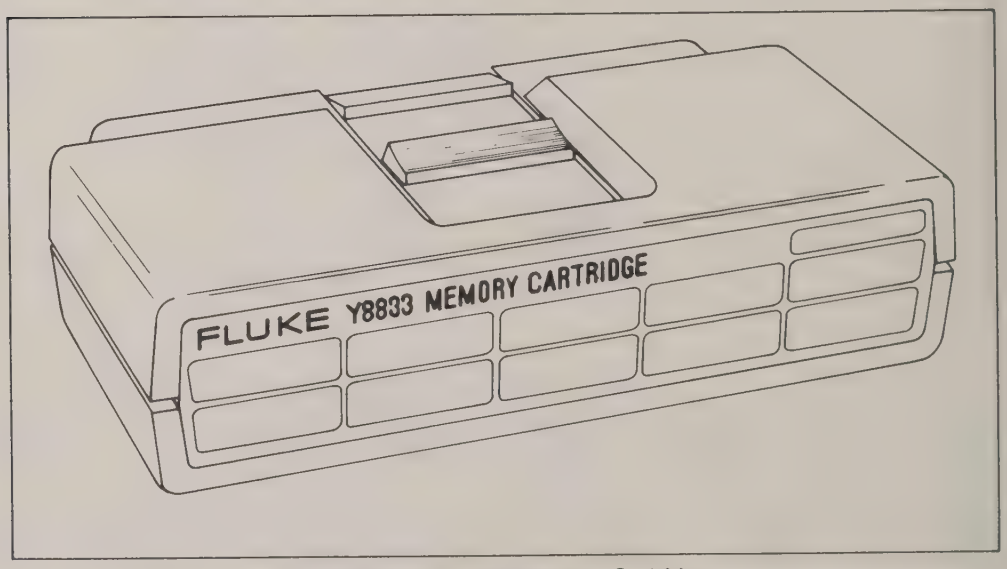


Figure 500-7. Y8833 Memory Cartridge

500-27. 80K-40 HIGH VOLTAGE PROBE

500-28. Description

500-29. 80K-40 is a high voltage probe designed to extend the ac and dc voltage measuring capability of the DMM up to 40 kV. The physical characteristics of the probe are shown in Figure 500-8. In essence, the probe is a 1000 :1 divider formed by two matched metal-film resistors. The unusually high input impedance offered by these resistors minimizes circuit loading and optimizes measurement accuracy. A special plastic body houses the divider and provides the user with isolation and protection form the voltage being measured. Requires a 10 MΩ resistor be placed across the output when 8860A is on the two lowest ranges.

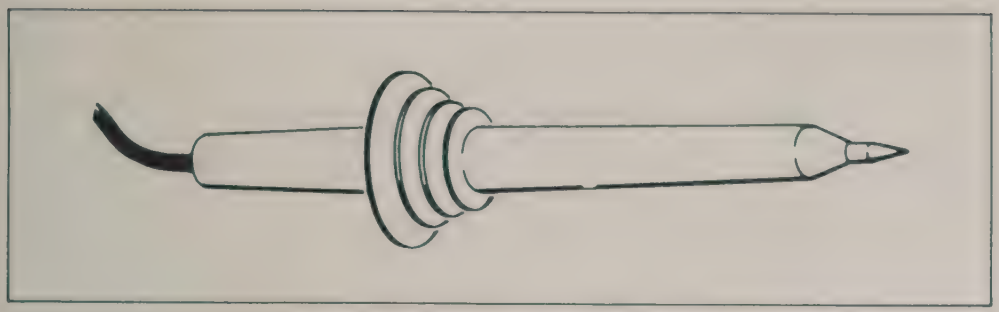


Figure 500-8. 80k-40 High Voltage Probe

500-30. Specifications

500-31. The following specifications assume that the probe is used with a voltmeter having a 10 megohm input impedance. A correction factor or a shunt resistor must be used if the input impedance of the voltmeter is other than 10 megohms.

VOLTAGE RANGE	1 kV to 40 kV dc or peak ac, 28 kV rms AC
INPUT RESISTANCE	1000 megohms
DIVISION RATIO	1000:1
ACCURACY	
DC	
1 kV to 20 kV	Linear change from ±4% to ±2%
20 kV to 30 kV	±2% (calibrated to 1% at 25 kV)
30 kV to 40 kV	Linear change from ±2% to ±4%
AC	±5% at 60 Hz

500-32. 80T-150 TEMPERATURE PROBE

500-33. Description

500-34. The Model 80T-150, as shown in Figure 500-9, is a universal temperature probe designed to provide a DMM with temperature measuring capability. Temperature is sensed at the probe tip and converted into a voltage for use by the DMM. The conversion factor is 1 mV per degree. Temperature scales in degrees Celsius or Fahrenheit may be specified at the time of purchase or selected by the user. Operating power for the probe is supplied by a disposable battery. Battery life is 1000 hours of continuous use. An on-off switch is provided to conserve battery life when the unit is not in use.

500-35. Specifications

RANGE	-50°C to +150°C, -58°F to +302°F
RANGE SELECTION	Internal Jumpers (and re-calibrate)
SENSITIVITY	1 mV per °C or °F
RESOLUTION	0.1°C or 0.1°F recommended maximum
AMBIENT TEMPERATURE	
RANGE	0°C to +50°C
RELATIVE HUMIDITY	<80% non condensing
ACCURACY	Including nomimal ±0.25% voltmeter error at +15°C to +35°C ambient. Add 1°C to the accuracy specifications if ambient temperature is below +15°C or above +35°C.
-50°C to -25°C	±3°C
-25°C to +125°C	±2°C
+125°C to +150°C	±3°C

VOLTMETER INPUT IMPEDANCE	⩾10 megohm
MAXIMUM VOLTAGE	Probe tip to circuit low, 350V dc or peak ac
SETTLING TIME	8 seconds to settle to within 1 degree after a 100 degree step change at the probe tip
POWER	Internal disposable battery, 1000 hours of continuous use
CONTROLS	Power on/off switch

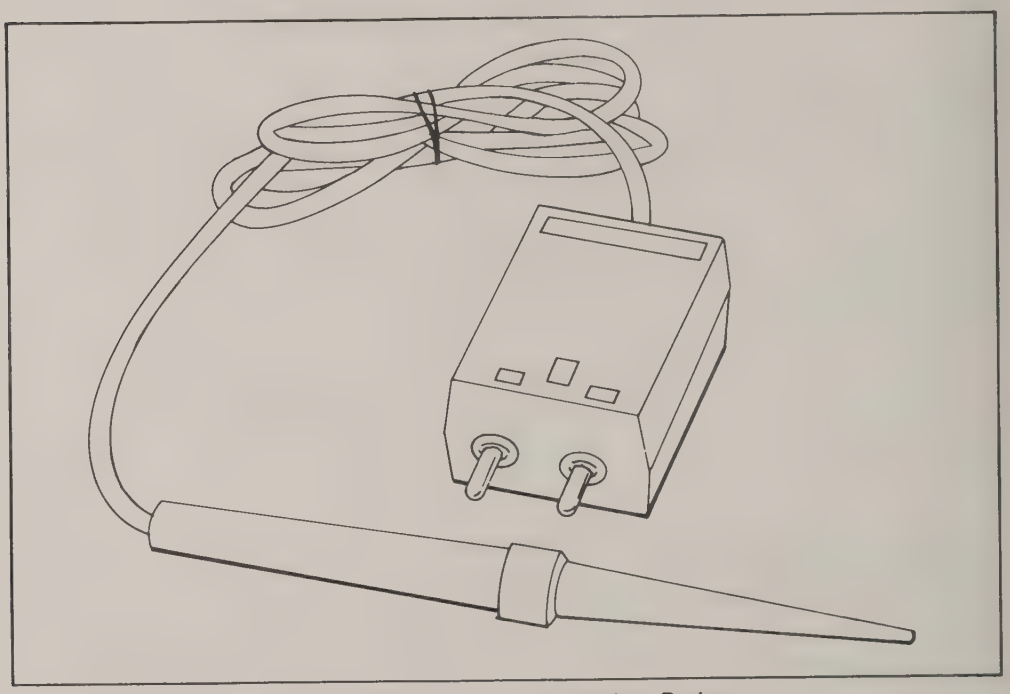


Figure 500-9. 80T-150 Temperature Probe

500-36. 81RF HIGH FREQUENCY PROBE

500-37. Description

500-38. The Model 81RF is designed to convert a dc voltmeter with a 10 megohm input impedance into a high frequency ac voltmeter. It provides a useful frequency range of 20 kHz to 250 MHz. Physical characteristics of the probe are shown in Figure 500-10. The output of the probe is a dc voltage calibrated to equal the rms value of a 1 MHz sine wave input. Requires a 10 MΩ resistor across output when 8860A is on two lowest ranges.

500-39. Specifications

FREQUENCY RESPONSE	±1 dB from 100 kHz to 100 MHz (Relative to ac/dc transfer ratio)

AC-to-DC TRANSFER RATIO (23 +5°C)

RMS Input (100 kHz)	DC Output
0.25 to 0.5V	0.25 to 0.5V ±1.5 dB
0.5 to 2.0V	0.5 to 2.0V ±0.5 dB
2.0 to 30V	2.0 to 30V ±1.0 dB

EXTENDED FREQUENCY RESPONSE	Useful for relative readings from 20 kHz to 250 MHz
RESPONSE	Responds to peak value of input; Calibrated to read rms value of a sine wave.
VOLTAGE RANGE	0.25 to 30V rms
MAXIMUM DC INPUT	350V dc
TEMPERATURE COEFFICIENT (0 to 18 °C, 28 to 50°C)	<0.1 of ac-to-dc transfer ratio specification per °C
INPUT IMPEDANCE	12 megohm shunted by 15 pF

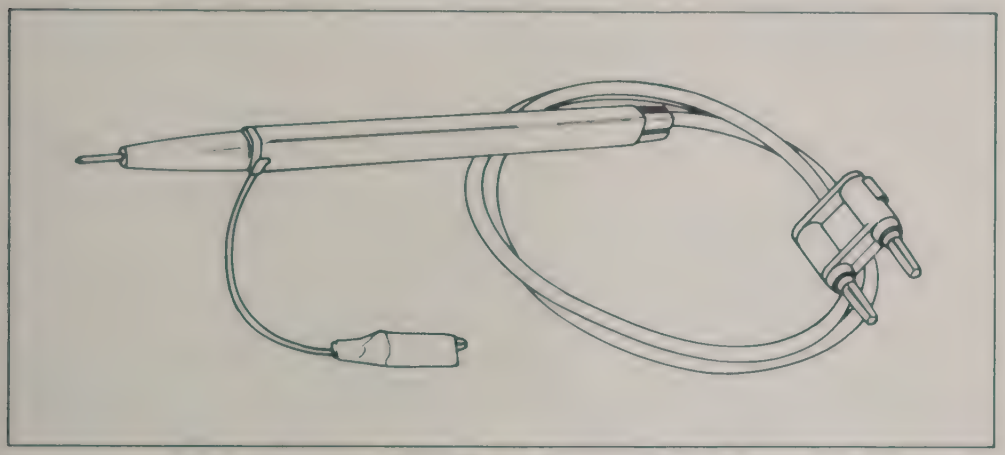


Figure 500-10. 81RF High Frequency Probe

500-40. 82RF HIGH FREQUENCY PROBE

500-41. Description

500-42. The Model 82RF is designed to convert a dc voltmeter with a 10 megohm input impedance into a high frequency voltmeter. It provides a useful frequency range of 20 kHz to 700 MHz. Physical characteristics of the probe are shown in Figure 500-11 (a BNC probe tip adapter is supplied with the 82RF). The output of the probe is a dc voltage calibrated to equal the rms value of a sine wave input. Requires a 10 MΩ resistor across the output when 8860A is on two lowest ranges.

500-43. Specifications

500-44. The frequency response and the ac-to-dc transfer ratio specifications assume the use of the BNC adapter supplied with the probe and a voltmeter with a 10 megohm input impedance shunted by less than 200 pF.

FREQUENCY RESPONSE	Relative to ac dc transfer ratio
100 kHz to 200 MHz	±1 dB
200 MHz to 500 MHz	±3 dB

AC-to-DC TRANSFER RATIO
(23 +5°C)

RMS Input (10 MHz)	DC Output
0.25 to 0.5V	0.25 to 0.5V ±1.5 dB
0.5 to 2.0V	0.5 to 2.0V ±0.5 dB
2.0 to 5.0V	2.0 to 5.0V ±1.0 dB
5.0 to 30V	5.0 to 30V ±1.5 dB

EXTENDED FREQUENCY RESPONSE	Useful for relative readings from 20 kHz to 700 MHz
RESPONSE	Responds to peak value of input; Calibrated to read rms value of a sine wave.
VOLTAGE RANGE	0.25 to 30V rms
MAXIMUM INPUT VOLTAGE	30V rms, 200V dc
INPUT IMPEDANCE	2 megohms shunted by <10 pF
TEMPERATURE COEFFICIENT	<0.1 of ac-to-dc transfer ratio specification per °C
OUTPUT CONNECTOR	Fits standard 0.75-inch spaced dual banana connectors
BNC ADAPTER	Slip-on BNC adapter is supplied with the probe

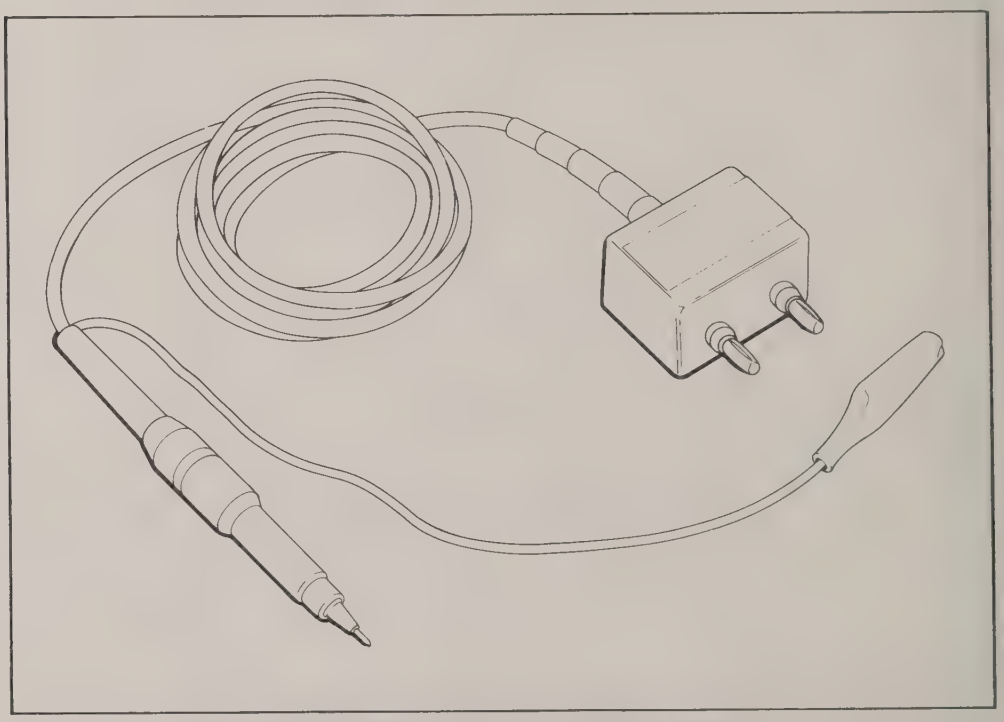


Figure 500-11. 82RF High Frequency Probe

500-45. 80J-10 CURRENT SHUNT

500-46. Description

500-47. The Model 80J-10 is a plug-in shunt designed to convert a voltmeter into a current meter. Two banana plugs, see Figure 500-12, with 0.75 inch spacing are used to connect the shunt to the input terminals of the voltmeter. Input connections to the shunt are made at two 5-way binding posts. The shunt value is selected to provide a 10 mV per ampere output.

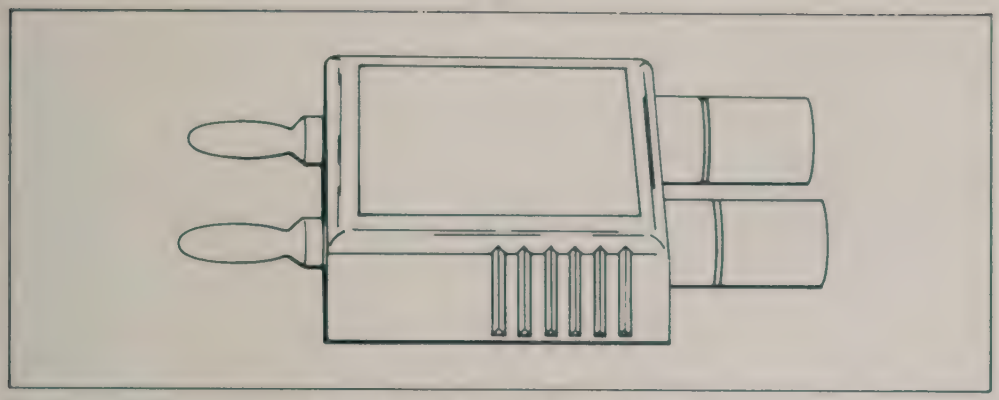


Figure 500-12. 80J-10 Current Shunt

500-48. Specifications

SENSITIVITY ..... 10 mV per ampere
SHUNT RESISTANCE ..... 0.01 ohms
ACCURACY ..... ±0.25% from dc to 10 kHz, rising 1 dB at 100 kHz
SERIES INDUCTANCE .... 8.3 nH
OVERLOAD ..... >20A, not fused

500-49. GENERAL PURPOSE ACCESSORIES

500-50. Several other general purpose accessories; such as adapters, connectors, and attenuators are available from Fluke. These are listed and described in Table 500-1.

Table 500-1. General Purpose Accessories

MODEL NO.	DESCRIPTION
Y9100	6 dB Attenuator (2X), 50 ohm, 2 watt, BNC
Y9101	14 dB Attenuator (5X), 50 ohm, 2 watt, BNC
Y9102	20 dB Attenuator (10X), 50 ohm, 2 watt, BNC
Y9103	50 ohm BNC Feed-Through Termination
Y9104	Alligator Clip to fit pin tip
Y9105	Alligator Clip to fit banana plug
Y9106	BNC Tee (3 Jacks)
Y9107	BNC Tee (Jack-Plug-Jack)
Y9108	BNC Jack to Dual Banana Plug
Y9109	Binding Posts to BNC Plug
Y9110	BNC Jack to PCB Pins
Y9111	3-Foot BNC Cable (97 cm)
Y9112	6-Foot BNC Cable (1 95m)
Y9113	BNC Plug to Dual Banana Plug
Y9114	BNC Jack to 1/4in. Phone Plug
Y9115	1/4in. Phone Jack to BNC Plug
Y9116	BNC Jack to Phono Plug
Y9117	Phono Jack to BNC Plug
Y9118	1/4in. Phone Jack to Dual Banana Plug
Y9119	Phono Jack to Dual Banana Plug

Option -004
Calculating Controller

004-1. INTRODUCTION

004-2. The Calculating Controller option is a programmable scientific calculator which has the 8860A DMM under its program control. Included in this option are the following three pieces of hardware:

1. A pair of circuit boards connected by a ribbon cable (mounted inside the 8860A chassis).

2. A handheld Control Keyboard (plugs into rear option board).

3. Memory Cartridge (also plugs into rear option board).

004-3. Use of this option is mutually exclusive with use of the IEEE-488 Interface option (-005). The Calculating Controller has the following features:

- SAMPLE key for initiating DMM measurements
- Programmable capability – 72 programmable functions
- Full scientific math function capabilities
- RPN logic with XYZT stack
- Non-volatile, interchangeable program memory (Memory Cartridge)
- 100 merged program steps
- 50 data registers, 10 of which are non-volatile
- Four levels of subroutines
- Indirect addressing capability
- Ten conditionals (eight for branching, two for loop control)
- I/O functions (for hardwiring to an external device)
- Printer functions (for accessory printer)

004-4. Documentation for the Calculating Controller is spread among four manuals as follows:

- 8860A Operator Manual -- option section. Brief description of Calculating Controller; installation procedure.

- 8860A Calculating Controller User Handbook. How to use the Control Keyboard; detailed description of each function; how to program the 8860A.

- 8860A Calculating Controller Reference Guide. Brief pocket-size summary of the User Handbook, with helpful reminders.

- 8860A Service Manual -- option section. Theory of operation; service information; parts lists; schematics.

004-5. INSTALLATION

004-6. The Calculating Controller option is field installable. Install the option as follows:

1. Disconnect the 8860A from its line power, remove all front (and rear) panel inputs.

2. Remove the four screws located on the bottom of the unit, and pull the top cover straight up and off.

3. Remove the 2-1/4in. x 3-3/4in. (60 x 90 cm) metal plate from the rear panel, by unscrewing the four screws which hold it in place.

4. Plug the large circuit board of the Calculating Controller into the option slot, as shown in Figure 004-1. Make sure the edge-connector tab at the bottom of the board plugs firmly into its socket. The two tabs at the top of the board fit into metal slots to hold it vertical.

5. Install the small printed circuit board inside the rear panel hole, and secure it with the four screws removed earlier.

6. Fold the excess ribbon cable between the transformer and the Rear Interface board, as shown in Figure 004-1.

7. Reinstall the top cover and secure it using the four cover screws.

004-7. OPERATION

004-8. Refer to the 8860A Calculating Controller User Handbook for operating instructions.

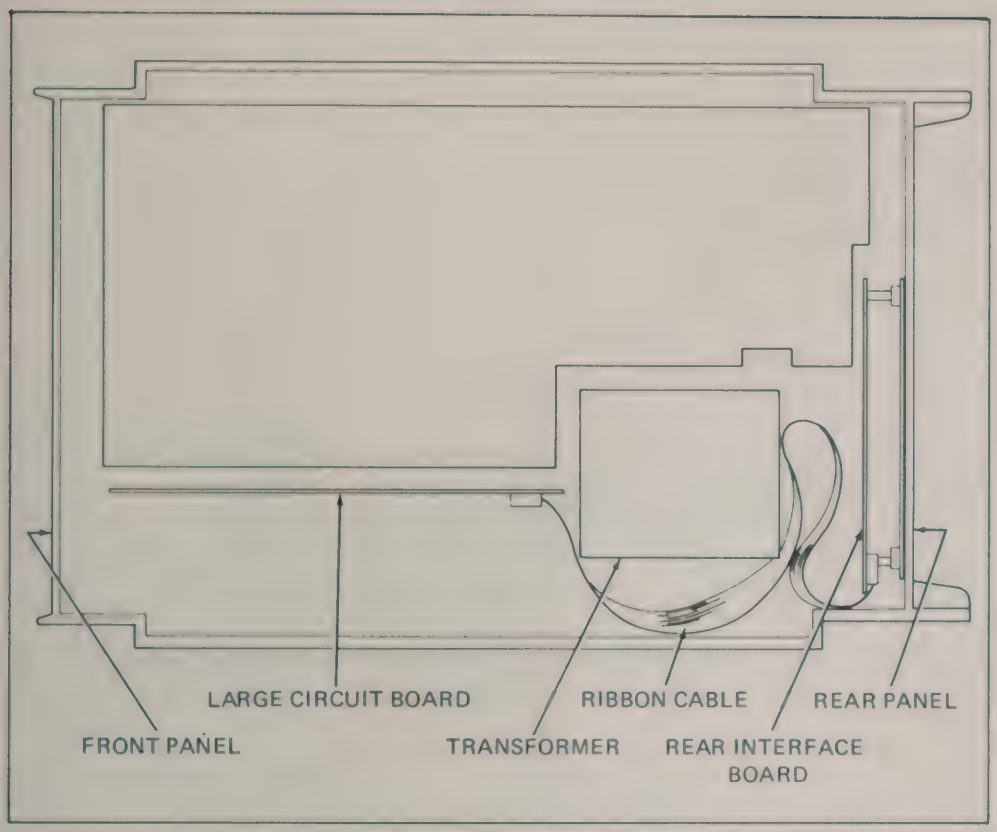


Figure 004-1. Top View of Calculating Controller Option

Option -006
Rear Input

006-1. INTRODUCTION

006-2. The Rear Input option relocates the five input connections from the 8860A front panel banana jacks to a 20-pin connector located at the rear panel. The 8860A then makes its voltage and resistance (both two- and four- terminal) measurements from this rear-input connector. With the Rear Input installed, the five front panel input jacks are completely disconnected. The Rear Input option is intended for system applications where single cable connections to the instrument are required.

006-3. This option is compatible with the External Reference option. The External Reference uses pins K and L of the 20-pin Rear Input connector.

006-4. SPECIFICATIONS

006-5. Specifications for the Rear Input option are identical to the front panel input specifications, except for slightly different input load characteristics: input capacitance approximately 30 pF added. The additional lead resistance of the Rear Input option requires rezeroing the DMM for the 200 ohm range. The voltage ratings between terminals are also identical to those printed on the front panel.

006-6. INSTALLATION

006-7. The Rear Input option is field installable. Install the option as follows:

1. Disconnect the 8860A from its line power, and remove all signals from the front panel inputs.

2. Unscrew the four screws located on the bottom of the unit, and pull the top cover straight up and off.

3. Remove the guard cover by unscrewing its four top screws. (The guard cover is the large, gold-colored metal cover with adjustment holes.)

4. Determine whether or not the External Reference (option -007) is installed. The External Reference is easily identified by a dual banana jack mounted in the rear panel where the rear input connector will go (as in Figure 006-1).

   a. If the External Reference is not installed in the 8860A:

      1. Remove the A/D-Ohms circuit board (see Figure 006-1) from the mainframe by lifting the board out.

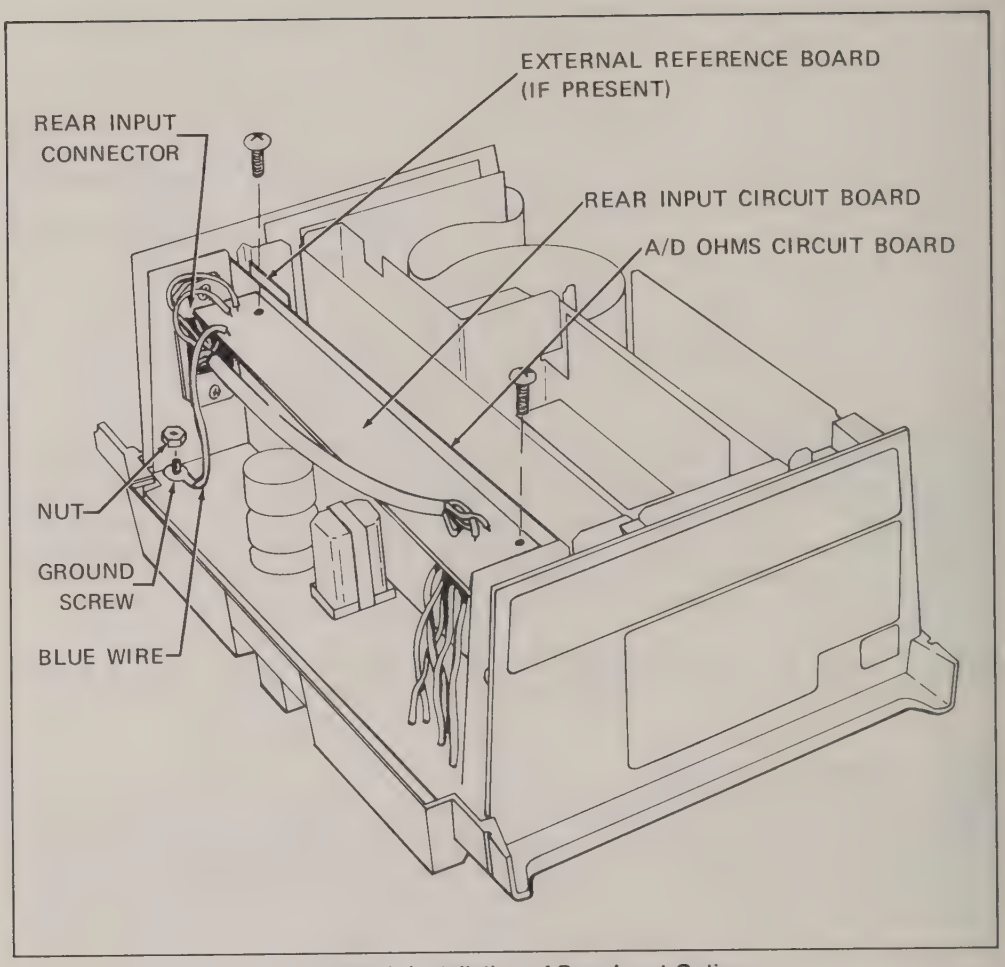


Figure 006-1. Installation of Rear Input Option

2. Remove the small (3/4in. x 1-1/2in.) plastic dummy plug, which covers a hole in the rear panel. Save this plastic plug. It can be reinserted if the Rear Input is ever removed.

b. If there is an External Reference installed:

1. Disconnect the two External Reference wires (Violet and Gray) from the dual banana jack mounted to the rear panel. These wires are force fitted; pull them straight out.

2. Remove the A/D-Ohms circuit board by lifting it out.

3. Remove the dual banana jack by unfastening its two screws.

4. Remove the External Reference circuit board (identified in Figure 006-1) from the A/D-Ohms circuit board by first unfastening the single screw holding it in place. This will allow the left-hand angle bracket of Figure 006-2 to be installed.

5. Disconnect the five input wires where they attach to the front panel input jacks by pulling them straight off.

6. Fasten the two small angle brackets to the A/D-Ohms board (already removed), using the two screws and nuts as shown in Figure 006-2. (Note each angle bracket has one threaded hole. Mount the non-threaded hole against the A/D-Ohms circuit board.)

7. If the External Reference option is being installed, then reinstall its circuit board on the A/D-Ohms board by first threading its two wires through the hole, and then fastening it with the single screw.

8. Orient the Rear Input connector with the holes marked A, B, C, and D at the top, as shown in the close-up, Figure 006-3. Fasten this connector to the rear panel with two screws, as in Figure 006-1.

9. Reinstall A/D-Ohms circuit board in its slot in the main instrument.

10. Connect the five color-coded wires to the Rear Analog input board according to the colors designated on that board. Push the connectors all the way on.

11. If the External Reference option is present, then connect the Violet and Gray wires of that option to the pins labeled VIO and GRA on the Rear Input circuit board. Push the connectors all the way on.

12. Fasten the Rear Input circuit board to the A/D-Ohms board by installing two screws in the angle brackets, as in Figure 006-1.

13. Lead the Blue ground wire behind the shielded wire, and to the ground screw in the corner of the guard, as in Figure 006-1. Using a nut, fasten the Blue wire to the ground screw.

14. Reinstall the guard cover (four screws).

15. Reinstall the top cover (four screws).

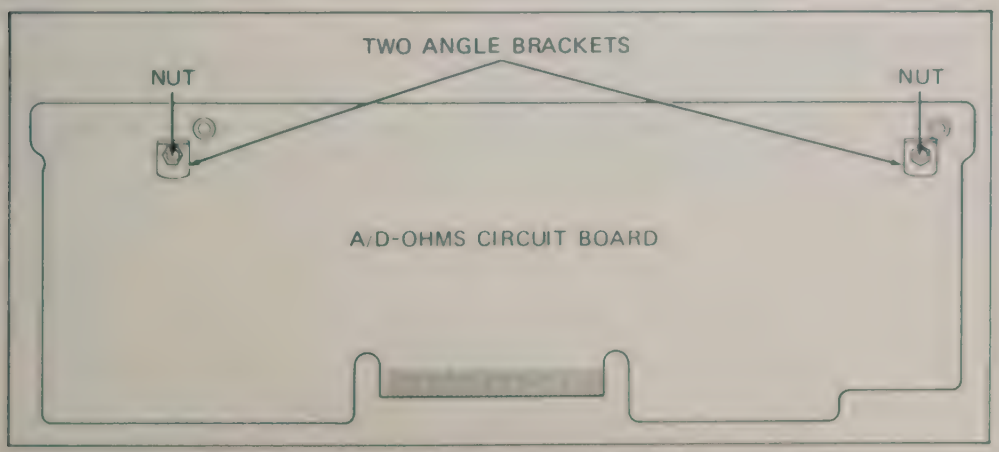


Figure 006-2. Installing Angle Brackets for Rear Input Option

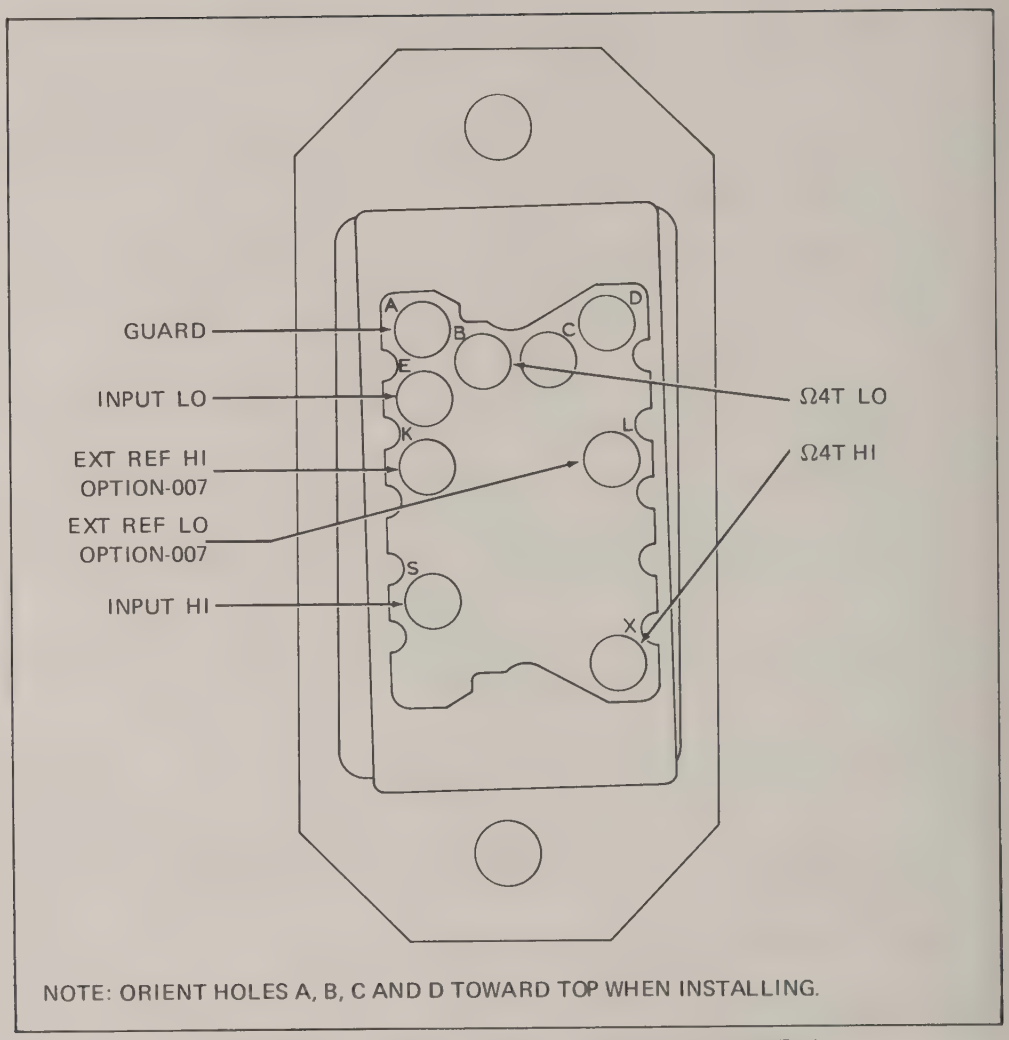


Figure 006-3. Rear Input Connector, Viewed from Plug End

006-8. OPERATION

006-9. Operation of the Rear Input is identical to that of the front panel inputs, except for the type of connector used. The pin designations are given in Figure 006-3. The plug which mates with the rear-panel-mounted Rear Input connector can be ordered using part number 541797, Hardware Connector Kit, from John Fluke Mfg. Co., Inc. This kit includes a cable connector (part # 369231), and the necessary solder contacts (part # 369298).

Option -007
External Reference

007-1. INTRODUCTION

007-2. The External Reference option (-007), when enabled, scales the display reading by the quantity 10 V_{REF}. It substitutes for the internal reference used by the analog-to-digital converter. The option is useful for measuring the ratio (multiplied by ten) of two voltages -- V_{IN} to V_{REF}.

007-3. SPECIFICATIONS

007-4. The specifications for the External Reference option are listed in Table 007-1. Note that the input resistance varies according to the circuit connections. Figure 007-1 shows the internal input stage of the External Reference, which causes this input resistance to differ according to the external connection to Input Lo.

Table 007-1. Specifications for External Reference Option

EXTERNAL REFERENCE	
Range	±1.0V DC to ±11.0V DC
Display	10(V_{IN}/V_{REF})
Accuracy	(1 yr, 18°C-28°C) add to specified accuracy for input range and function
5-1/2 DIGIT	±(.01% + 2 Digits) x (10/V_{REF})
4-1/2 DIGIT	±(0.01% + 2 Digits) x (10/V_{REF})
3-1/2 DIGIT	±(2 Digits) x (10/V_{REF})
Input Resistance	2 MΩ when EXT REF HI is tied to INPUT LO 1 MΩ when EXT REF LO is tied to INPUT LO
Maximum Input	±11V EXT REF HI to LO ±11V EXT REF LO to INPUT LO ±11V EXT REF HI to INPUT LO

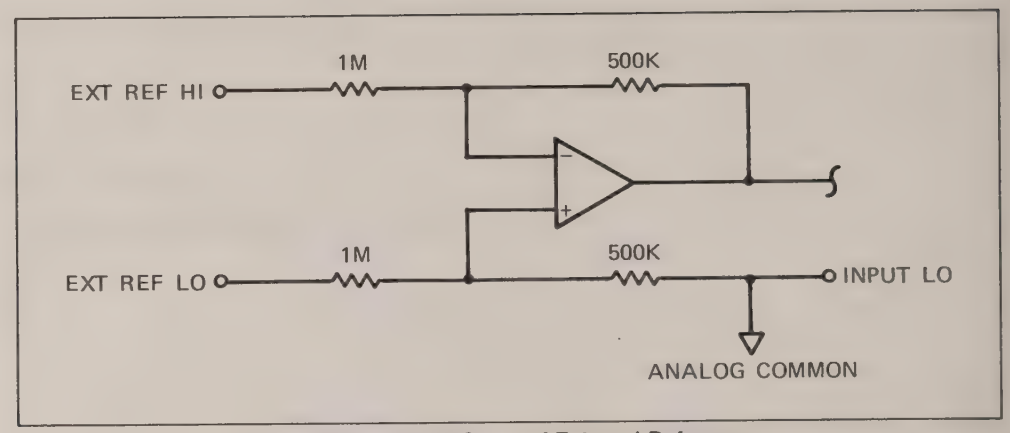


Figure 007-1. Input Stage of External Reference

007-5. INSTALLATION

007-6. The External Reference option (-007) is field installable. This option is compatible with the Rear Input option (-006). The following procedure describes installation of the External Reference (Ext. Ref.) without the Rear Input option.

007-7. If the External Reference option is being installed with the Rear Input option, the 20-pin Rear Input connector will be used rather than the dual banana jacks. In this case, follow the installation procedure given in the Rear Input option.

1. Disconnect the 8860A from its line power; remove all signals from its front (and rear) panel inputs.

2. Remove the top cover by unscrewing the four screws located on the bottom of the unit and pulling the cover straight up and off.

3. Remove the guard cover by unscrewing its four top screws. (The guard cover is the large, gold-colored metal cover with adjustment holes.)

4. Lift out the A/D-Ohms circuit board, shown in Figure 007-2.

5. Thread the two wires (Gray and Violet) from the External Reference circuit board through the hole at the rear, and from the component side of the A/D-Ohms board, as in Figure 007-2.

6. Plug the External Reference board into the A/D-OHMS board (9-pin connector). Fasten the External Reference board in place with a screw from the other side.

7. Reinstall the A/D-Ohms circuit board into its slot in the main instrument.

8. Remove the small (3/4in. x 1-1/2in.) dummy plug, which covers a hole in the rear panel, by pushing it out. Save this plug; it can be reinserted if the Rear Input is ever removed.

9. From the inside, install the dual banana jack connector in the rear panel hole. Fasten it with two screws. You will need a short, stubby screwdriver or a right-angle screwdriver to fasten the lower screw.

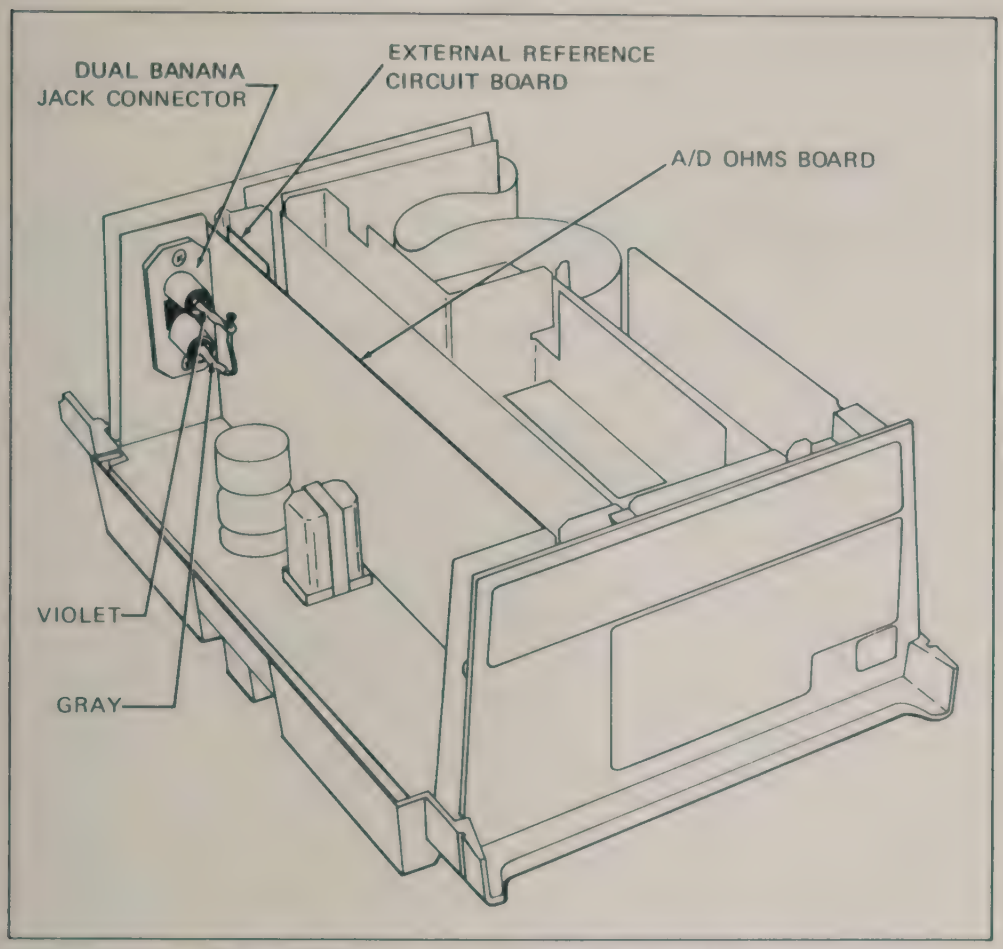


Figure 007-2. Installation of External Reference Option

10. Connect the Gray wire to the lower jack and the Violet wire to the upper jack, as in Figure 007-2.

11. Reinstall the guard cover (four screws).

12. Calibrate REF GAIN, NULL, and REF OFFSET pots according to the instructions given under External Reference in the 8860A Calibration Manual. These three pots are located on the External Reference circuit card.

13. Reinstall the top cover (four screws).

007-8. OPERATION

NOTE

The External Reference conditioning circuitry will not operate if the external voltage is not referenced to the front panel INPUT LO. This can be accomplished by tying either end of the external reference to INPUT LO, or referencing it to some constant voltage above or below INPUT LO.

007-9. To operate the External Reference option, use the following procedure.

1. Apply a dc voltage to the External Reference connector (the upper pin is positive).

2. Select the appropriate function and range.

3. Activate the External Reference (and disable the internal reference) by pressing FCN, EXT REF on the 8860A front panel. The indicator light next to the EXT REF switch turns on.

4. For voltage measurements, the display will now read a number equal to:

$$V_{IN} \times \frac{10}{V_{REF}}$$

and for resistance measurements:

$$R_{IN} \times \frac{10}{V_{REF}}$$

Appendix A
Fluke Sales and Service Centers

Authorized Fluke Sales Representative and Service Centers are available at various worldwide locations. Table A-1 and A-2 provide a complete list of service centers. The Fluke Sales Representatives are listed in Tables A-3 and A-4.

Table A-1. Fluke Technical Service Centers - U.S. and Canada

UNITED STATES

CA, Burbank
Fluke Technical Center
2020 N. Lincoln Street
Burbank, CA 91504
(213) 849-4641

CA, Santa Clara
Fluke Technical Center
2300 Walsh Avenue
Santa Clara, CA 95050
(408) 985-1200

CO, Denver
Fluke Technical Center
1980 S. Quebec Street, Unit 4
Denver, CO 80231
(303) 750-1228

FL, Orlando
Fluke Technical Center
940 N. Fern Creek Avenue
Orlando, FL 32803
(305) 896-2296

IL, Rolling Meadows
Fluke Technical Center
1400 Hicks Road
Rolling Meadows, IL 60008
(312) 398-5800

MA, Waltham
Fluke Technical Center
244 Second Avenue
Waltham, MA 02154
(617) 890-1604

MD, Rockville
Fluke Technical Center
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1576

MN, Apple Valley
Fluke Technical Center
7373 West 147th Street, Suite 196
Apple Valley, MN 55124
(612) 432-9400

NC, Greensboro
Fluke Technical Center
1310 Beaman Place
Greensboro, NC 27408
(919) 273-1918

NJ, Paramus
Fluke Technical Center
West 75th Century Road
Paramus, NJ 07652
(210) 262-9550

TX, Dallas
Fluke Technical Center
14400 Midway Road
Dallas, TX 75240
(214) 233-9945

WA, Mountlake Terrace
John Fluke Mfg. Co., Inc.
21707 66th Avenue W., Suite 1
Mountlake Terrace, WA 98043
(206) 774-2206

CANADA

ALB, Calgary
Allan Crawford Assoc., Ltd.
1935 30th Avenue N.E. #14
Calgary, ALB T2E 6Z5
(403) 230-1341

ONT, Mississauga
Allan Crawford Assoc., Ltd.
6503 Northam Drive
Mississauga, ONT L4V 1J5
(416) 678-1500

QUE, St. Laurent
Allan Crawford Assoc., Ltd.
7018 Cote de Liesse
St. Laurent, QUE H4T 1E7
(514) 731-8564

Table A-2. Fluke Technical Service Centers - International

ARGENTINA
Fluke Latin American
Service Headquarters
Virrey del Pino 4071
Buenos Aries, Argentina
Tel. 523185

AUSTRALIA
Elmeasco Instrument Pty Ltd.
P.O. Box 30
Concord, N.S.W
Australia 2137
Tel: (02) 736-2888

AUSTRIA
Walter Rekirsch
Elektronische Gerate GmbH & Co.
Vertriebs-KG.
Liechtensteinstrasse 97/6
A-1090 Vienna, Austria
Tel. 09-43-222-347646

BELGIUM
Fluke (Belgium)S.A./N.V
6, Rue de Geneve
1140 Brussels, Belgium
Tel 09-32-2-2164090

BRAZIL
Arotec S A
Industria e Comercio
Av Pacaembu 811
01234 Sao Paulo S.P., Brazil
Tel 826-2266

CHILE
Intronica Chile Ltda.
Casilla 16228
Santiago 9, Chile
Tel: 44940

COLOMBIA
Coasin Ltda.
Carrera 13, # 37-37, Of. 407
Ap. Aero 29583
Bogota DE, Colombia
Tel: 285-0230

DENMARK
Tage Olsen A/S
Ballerup Byvej 222
DK-2750 Ballerup
Denmark
Tel: (01) 2-65 81 11

ECUADOR
Protéco Coasin Cia., Ltda
Edificia "Jerico"
Ave. 12 de Octubre #2285y
Ave. Orellana (Planta Baja)
Quito, Ecuador
Tel: 526759

EGYPT
Lotus Engineering Organisation
P O Box 1252
Cairo, Egypt
Tel. 71617

FINLAND
Oy Findip AB
Teollisuustie 7
02700 Kauniainen
Finland
Tel: 09-358-0-502255

FRANCE
M.B. Electronique S.A.
Rue Fourny
ZAC de BUC
B.P. #31
78530 BUC, France
Tel: 09-33-1-9568131

GREECE
Hellenic Scientific
Representations Ltd
11, Vrassida Street
Athens 615, Greece
Tel: 09-30-1-711140

HONG KONG
Gilman Industrial Bldg., 9F
107-109 Wai Yip Street
Kwun Tong
Kowloon, Hong Kong
Tel: 3-427144

Table A-2. Fluke Technical Service Centers - International (cont)

INDIA
Hinditron Services Pvt Ltd
"Hinditron House"
412 Raj Mahal Vilas Extension
Bangalore 560 006, India
Tel 33139

Hinditron Services Pvt. Ltd
69 A.L. Jagmohandas Marg
Bombay 400 006, India
Tel 365344

INDONESIA
P.T. Dwi Tunggal Jaya Sakti
Sangga Buana Bldg., 1st Floor
J1 Senen Raya 44, P.O. Box 4435
Jakarta, Indonesia
Tel 376608

IRAN
Irantronics Company Ltd.
20 Salm Road
Roosevelt Avenue
Tehran, Iran
Tel 828294/831564

ISRAEL
R.D.T. Electronics Engineering Ltd.
P.O. Box 75
46, Sokolov Street
Ramat Hasharon 47235
Israel
Tel 09-972-3-483211

ITALY
Sistrel S.p.A.
Via Timavo 66
20099 Sesto S. Giovanni (Milan)
Italy
Tel 09-39-2-2476693

Sistrel S.P.A.
Via Guiseppe Armellini #37
00143 Rome, Italy
Tel 09-39-6-5915551

JAPAN
John Fluke Mfg. Co., Inc.
Japan Branch
1 Higashikata-machi
Midori-ku
Yokohama 226, Japan
Tel (045) 473-5425

KOREA
Electro Science Korea Co.
C.P.O. Box 8446
Room 1201 Bowon Bldg.
49[illegible]5 Ka
Chungro-ku
Seoul, Korea
Tel 267-7[illegible]

MALASIA
[illegible] Malaysia SDN. BHD.
P.O. Box 97
Petaling Jaya, Selangor
West Malaysia
Tel 51566

MEXICO
C.J. Christensen S.A. De C.V.
Melchor Ocampo 150-8
Mexico 4 D.F., Mexico
Tel (905) 535-2258

NETHERLANDS
Fluke (Nederland) B.V.
P.O. Box 5053
5004 EB Tilburg
The Netherlands
Tel: (013) 673973

NEW ZEALAND
W & K McLean Ltd
P.O. Box 18065
Glen Innes
Auchland, New Zealand
Tel 587-037

NORWAY
Morgenstierne & Co. A/A
Konghellegate 3
P.O. Box 6688, Rodelokka
Oslo 5, Norway
Tel 09-47-2-356110

PAKISTAN
Pak International Operations
505 Mohammadi House
1.1. Chundrigar Road
Katrachi-2 Pakistan
Tel 221127/239052

PERU
Importaciones Y Representaciones
Electronicas S.A.
Avda. Franklin D. Roosevelt 105
Lima 1, Peru
Tel 288650

PORTUGAL
Equipamentos de Laboratorio, Ltda.
P.O. Box 1100
Lisbon 1002, Portugal
Tel 09-351-1-578936/547512

REPUBLIC OF SINGAPORE
Rank O'Connor's (PTE) Ltd
98 Pasir Panjang Road
Singapore 0511
Republic of Singapore
Tel 637944

REPUBLIC OF SOUTH AFRICA
Fluke S.A. (Pty) Ltd
P.O. Box 39797
Bramley 2018
Republic of South Africa
Tel (011) 786-3170

SPAIN
Hispano Electronica S.A.
Apartado de Correos 48
Alcorcon (Madrid)
Spain
Tel 09-3416194108

SWEDEN
Teleinstrument AB
P.O. Box 490
S-162 Vallingby 4
Sweden
Tel 09-46-8-380370

SWITZERLAND
Traco Electronic AG
Jenatschstrasse 1
8002 Zurich
Switzerland
Tel 09-41-1-2010711

TAIWAN
CCT Associates, Inc.
P.O. Box 24209
Taipei, Taiwan
Republic of China
Tel (02) 391-6894/393-5760

THAILAND
Dynamic Supply Engineering R.O.P.
56 Ekamai, Sukhumvit 63
Bangkok-11, Thailand
Tel 914434 928532

TURKEY
Erkman Electronik Aletler
Ticaret Anonim Sirketi
Necatiby Cad 92/3
Karakoy, Istanbul, Turkey
Tel 09-44-1-5461

UNITED KINGDOM
Fluke International Corp. - UK
Colonial Way
Watford, Herts. WD24TT
United Kingdom
Tel 09-4492340511

URUGUAY
Coasin Uruguaya S.R.L.
Edificio Ciudadela
Sarandi 690 D. Esc. 109
Casilla de Correos 1400
Correo Central
Montevideo, Uruguay
Tel 917978

VENEZUELA
Coasin C.A.
Apdo. Postal 50939
Sabana Grande # 1
Caracas 105, Venezuela
Tel 782-9109

WEST GERMANY
Fluke (Deutschland) GmbH
Krausstrasse 32
8045 Ismaning
West Germany
Tel (089) 96251

Customers in the following countries: Bulgaria, Czechoslovakia, Hungary, Poland, Romania, U.S.S.R., and Yugoslavia contact Amtest Associates Ltd., P.O. Box 55, Addlestone, Surrey, KT 15 1DU, England. Tel (0932) 52121

Table A-3. Sales Representatives - U.S. and Canada

UNITED STATES

AK, Anchorage
Harry Lang & Associates
1371 Hillcrest Drive #303
Anchorage, AK 99503
(907) 279-5741

AL, Huntsville
John Fluke Mfg. Co., Inc.
3322 Memorial Parkway
Huntsville, AL 35807
(205) 881-6220
(404) 321-0980 (Atlanta)

AZ, Tempe
John Fluke Mfg. Co., Inc.
2125 S. 48th Street, Suite 104
Tempe, AZ 85285
(602) 967-8724

CA, Los Angeles
John Fluke Mfg. Co., Inc.
20902 S. Bonita Street
Carson, CA 90746
(213) 538-3900

CA, Santa Clara
John Fluke Mfg. Co., Inc.
2300 Walsh Avenue
Santa Clara, CA 95050
(408) 244-1505

CA, Tustin
John Fluke Mfg. Co., Inc.
15445 Red Hill Avenue, Suite F
Tustin, CA 92680
(714) 838-8863
(714) 226-1254 (San Diego)

CO, Denver
John Fluke Mfg. Co., Inc.
1980 S. Quebec, #4
Denver, CO 80231
(303) 750-1222

CT, Hartford
John Fluke Mfg. Co., Inc.
124 Hebron Avenue
Glastonbury, CT 06033
(203) 633-0777

FL, Orlando
John Fluke Mfg. Co., Inc.
940 N. Fern Creek Avenue
Orlando, FL 32803
(305) 896-4881

HI, Honolulu
EMC Corporation
2979 Ualena Street
Honolulu, HI 96819
(808) 847-1138

IA, Iowa City
John Fluke Mfg. Co., Inc.
1027 Hollywood Blvd., Suite 309
Iowa City, IA 52240
(319) 354-2811

IL, Chicago
John Fluke Mfg. Co., Inc.
4300 Lincoln, Unit K
Rolling Meadows, IL 60008
(312) 398-0850

IN, Indianapolis
John Fluke Mfg. Co., Inc.
5610 Crawfordsville Road,
Suite 802
Indianapolis, IN 46224
(317) 244-2456

LA, Metairie
John Fluke Mfg. Co., Inc.
2700 Kingman Street, Suite 103
Metairie, LA 70002
(504) 455-0814

MA, Waltham
John Fluke Mfg. Co., Inc.
244 Second Avenue
Waltham, MA 02154
(617) 890-1600

MD, Baltimore
John Fluke Mfg. Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570
(301) 792-7060 (Baltimore)

MI, Detroit
John Fluke Mfg. Co., Inc.
13955 Farmington Road
Livonia, MI 48154
(313) 522-9140

MN, Minneapolis
John Fluke Mfg. Co., Inc.
7373 W. 147th Street, Suite 196
Apple Valley, MN 55124
(612) 432-9400

MO, Kansas City
John Fluke Mfg. Co., Inc
4406 Chouteau Traffic Way
Kansas City, MO 64117
(816) 454-5836

MO, St. Louis
John Fluke Mfg. Co., Inc.
300 Brookes Drive, Suite 100
Hazelwood, MO 63042
(314) 731-3388

NC, Greensboro
John Fluke Mfg. Co., Inc
1310 Beaman Place
Greensboro, NC 27408
(919) 273-1918

NJ, Paramus
John Fluke Mfg. Co., Inc
West 75 Century Road
Paramus, NJ 07625
(201) 262-9550

NM, Albuquerque
John Fluke Mfg. Co., Inc.
1108 Alvarado Drive N.E.
Albuquerque, NM 87110
(505) 265-8431

NY, Rochester
John Fluke Mfg. Co., Inc.
4515 Culver Road
Rochester, NY 14622
(716) 266-1400

OH, Cleveland
John Fluke Mfg. Co., Inc.
7830 Freeway Circle
Middleburg Heights, OH 44130
(216) 234-4540

OH, Dayton
John Fluke Mfg. Co., Inc.
4756 Fishburg Road
Dayton, OH 45424
(513) 233-2238

OR, Portland
John Fluke Mfg. Co., Inc.
18360 S.W. Springfield Lane
Aloha, OR 97006
(502) 642-1342

PA, Philadelphia
John Fluke Mfg. Co., Inc.
1010 W. 8th Avenue, Suite H
King of Prussia, PA 19406
(215) 265-4040
(412) 261-5171 (Pittsburgh)

TX, Austin
John Fluke Mfg. Co., Inc.
111 W. Anderson Lane, Suite 213
Austin, TX 78752
(512) 478-9901

TX, Dallas
John Fluke Mfg. Co., Inc
14400 Midway Road
Dallas, TX 75243
(214) 233-9990

TX, Houston
John Fluke Mfg. Co., Inc.
1014 Wirt Road, Suite 270
Houston, TX 77055
(713) 683-7913
(512) 222-2726 (San Antonio)

UT, Salt Lake City
John Fluke Mfg. Co., Inc
782 E. 8325 South
Sandy, UT 84070
(801) 566-4864

WA, Kennewick
John Fluke Mfg. Co., Inc
3613 W. 16th Place #C
Kennewick, WA 99336

WA, Seattle
John Fluke Mfg. Co., Inc.
975 Industry Drive
Seattle, WA 98188
(206) 575-3765

For more information on Fluke products or Sales Offices you may dial (800) 426-0361 toll free in most of U.S. From Alaska, Hawaii, Washington, or Canada phone (206) 774-2481. From other countries phone (206) 774-2398.

Table A-3. Sales Representatives - U.S. and Canada (cont)

CANADA

ALB, Calgary
Allan Crawford Assoc . Ltd
1935 30th Avenue N E . #14
Calgary, ALB T2E 6Z5
Tel (403) 230-1341

BC, North Vancouver
Allan Crawford Assoc . Ltd
3795 William Street
Burnaby, BC Y5C 3H3
Tel (604) 294-1326

NS, Halifax
Allan Crawford Assoc . Ltd
Townsend Place, Suite 201
800 Windmill Road
Burnside Industrial Park
Dartmounth, NS B3B 1L1
Tel (902) 469-7865

ONT, Ottawa
Allan Crawford Assoc . Ltd
1299 Richmond Road
Ottawa, ONT K2B 7Y4
Tel (613) 829-9651

ONT, Toronto
Allan Crawford Assoc Ltd
6503 Northam Drive
Mississauga, ONT L4V 1J5
Tel (416) 678-1500

QUE, Montreal
Allan Crawford Assoc . Ltd
7018 Cote de Liesse
St Laurent, QUE H4T 1E7
Tel (514) 731-8564

For Canadian areas not listed, contact the office nearest you or Allan Crawford Assoc. Ltd., Mississauga (Toronto), Ontario.

Table A-4. Sales Representatives - International

Supplied and Supported by Fluke International Corporation, P.O. Box 43210, Mountlake Terrace, WA 98043, Tel: (206) 774-2398, TLX: 152662 JOHNFLUKE MTLT

ARGENTINA
Coasin S A
Virrey del Pino 4071
Buenos Aires, Argentina
Tel 525130
TLX 390122284 COASN AR

AUSTRALIA
Elmeasco Instruments Pty Ltd
P O Box 30
Concord, N S W
Australia 2137
Tel (2) 736-2888
TLX 79025887

Elmeasco Instruments Pty Ltd
P O Box 107
Mt Waverly, VIC 3149
Australia
Tel 233-4044
TLX 26206 (ELMVIC)

Elmeasco Instruments Pty Ltd
Professional Suite's Bldg
B P O Box 2360
Brisbane, 4001
Australia
Tel (07) 229-3161

Elmeasco Instruments Pty Ltd
[illegible]
G P O Adelaide 5001
South Australia

BOLIVIA
[illegible]
[illegible]
La Paz, Bolivia
Tel 40962
TLX [illegible] indicate
Para Louis F B S R L. Av E
de Agosto 2308 3er Piso La Paz
T 40962

BRAZIL
Arotec S.A.
Industria e Comercio
Av Pacaembu 811
01234 Sao Paulo S P , Brazil
Tel (011) 67-2393
TLX 1122207 AROT BR

Arotec S A
Rua Araguari, 1705 s 402
30 000 Belo Horizonte M G , Brazil

Arotec S A
Av Rio Branco 277
Grupo 1309
02000 Rio de Janeiro, R J , Brazil
Tel (021) 242-9776

BRUNEI
O'Connor's Limited
(Brunei Branch) Chin Kian Bldg
P O Box 2126
Bandar Seri Begawan, Brunei
Tel 26680

CHILE
Intronica Chile Ltda
Manuel Montt 024 - Of D
Casilla 16228
Santiago 9, Chile
Tel 44940
TLX 40301 Cab Publ .
Attn Intronica Chile

CHINA, PEOPLE'S REPUBLIC OF
China National Instrument Import & Export Corp
P O Box 49 Erh-Li-Kou
Hsi Chi ao
Beijing
People's Republic of China
TLX CO 2242 CNIEC

COLOMBIA
Coasin Ltda
Carrera 13, # 37-37, Of 407
Ap Aero 29583
Bogota DE, Colombia
Tel 285-0230 0250
TLX 45787 COASN CO

ECUADOR
Proteco Coasin Cia . Ltda
Edificio "Jerico"
Ave 12 de Octubre #2285 y
Ave Orellana (Planta Baja)
Quito Ecuador
Tel 529684
TLX 2865 Protec Ed

Proteco Coasin Cia . Ltda
Casilla 9733
9 de Octubre 424
Edificio Gran Pasaje, Of 1012
Guayaquil, Ecuador

HONG KONG
Gilman & Co., Ltd
P O Box 56
Gilman Ind Bldg 9 F
107-109 Wai Yip Street
Kwun Tong Kowloon
Hong Kong
Tel 5-7909633
TLX 73358 GILMN HX

ICELAND
Kristjan O Skagfjord Ltd
P O Box 906
Reykjavik, Iceland
Tel 24120
TLX 2133 KOS IS

INDIA
Hinditron Services Pvt Ltd
69 A L Jagmohandas Marg
Bombay 400 006
India
Tel 811316
TLX 953-112326 Hspl In

Table A-4. Sales Representatives - International (cont)

Hinditron Services Pvt. Ltd.
"Hinditron House"
412 Raj Mahl Vilas Extension
Bangalore 560 006
India
Tel: 33139
TLX: 043741

INDONESIA
P.T. Dwi Tunggal Jaya Sakti
Sangga Buana Bldg., 1st Floor
Jl. Senen Raya 44, P.O. Box 4435
Jakarta, Indonesia
Tel: 367390-9
TLX: 46624 SABUANA 1A

P.T. Dwi Tunggal Jaya Sakti
Jalan Sasakgantung 45
Bandung, Indonesia
Tel: 367390-9
TLX: 46624 SABUANA 1A

JAPAN
John Fluke Mfg. Co., Inc.
Japan Branch
(PC Board Testers only)
1 Higashikata-machi
Midori-ku
Yokohama 226, Japan
Tel: (045) 473-5425
TLX: 3823-666 FLUKJPJ

Tokyo Electron Ltd.
38 Fl. Shinjuko Nomura Bldg.
1-26-2, Nishi-Shinjuku
Shinjuku-ku
Tokoyo 160, Japan
Tel: 03-343-4411
TLX: 2322220 LABTEL J

KENYA
Advanced Communications Ltd.
P.O. Box 30070
Nairobi, Kenya
East Africa
Tel: 331955
TLX: 22639 ADCOM

KOREA
Electro-Science Korea Co.
C.P.O. Box 8446
Room. 1201 Bowon Bldg
490 Chongro - 5 Ka
Chongro-ku
Seoul, Korea
Tel: 261-7702
TLX: 78723270+

MALAYSIA
O'Connor's (PTE) Limited
P.O. Box 91
Petaling Jaya, Selangor
West Malaysia
Tel: 51563
TLX: OCONOR MA37649

O'Connor's (PTE) Limited
Lot # 5 Taman Mesra
Mile 3, Jalan Penampang
Kota Kinabulu
East Malaysia
Tel: 55322
TLX: MA80286FL

MEXICO
C.J. Christensen S.A. De C.V.
Instrumentos Electronicos
de Medicion
Melchor Ocampo 150-8
Mexico 4 D.F., Mexico
Tel: (905) 535-2258

NEW ZEALAND
W & K McLean Ltd.
P.O. Box 18065
Glen Innes
Auckland, New Zealand
Tel: 587-037
TLX: N.Z. 7912763

W & K McLean Ltd.
P.O. Box 2421
Christchurch, New Zealand

W & K McLean Ltd.
P.O. Box 496
Wellington, New Zealand
Tel: 851-450

NIGERIA
Mofat Engineering Co., Ltd.
P.O. Box 6369
Lagos, Nigeria
TLX: 21353, Attn: MOFAT

PAKISTAN
Pak International Operations
505 Muhammadi House
- McLeod Road
P.O. Box 5323
Karachi, Pakistan
Tel: 221127
TLX: 24494 PIO PK

PERU
Importaciones Y Representaciones
Electronicas S.A.
Avda. Franklin D. Roosevelt 105
Lima 1, Peru
Tel: 288650
TLX: 37425663

SINGAPORE
Rank O'Connor's (PTE) Limited
98 Pasir Panjang Road
Singapore 0511
Republic of Singapore
Tel: 637944
TLX: OCONSIN RS21023

SOUTH AFRICA
Fluke S.A. (Pty) Ltd.
P.O. Box 39797
Bramley 2018
Republic of South Africa
Tel: (011) 786-3170
TLX: 82899

TAIWAN
CCT Associates, Inc.
P.O. Box 24209
Taipei, Taiwan
Republic of China
Tel: (02) 391-6894
TLX: 24263 Longgulf

THAILAND
Dynamic Supply Engineering R.O.P.
56 Ekamai, Sukhumvit 63
Bangkok-11, Thailand
Tel: 914434
TLX: TH 82938 MONTIEN TH

URUGUAY
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TLX 722518

PK Electronik
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Piligono Industrial Urtinsa
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TLX: 22404/42634

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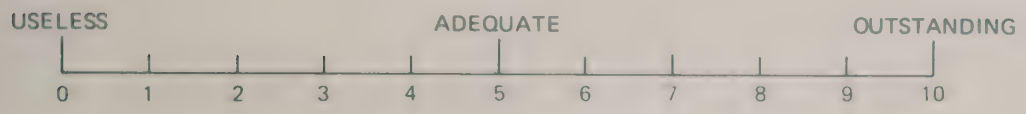

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